“ROLE OF ULTRASOUND ELASTOGRAPHY IN THE EVALATION OF THYROID NODULES WITH CYTOLOGICAL CORRELATION”

DISSERTATION SUBMITTED TO

THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI

IN PARTIAL FULFILLMENT OF THE REGULATIONS FOR THE AWARD OF DEGREE OF M.D IN RADIODIAGNOSIS.

BY

DR. SUKITHRA.S

GUIDE : DR .DEVANAND.B

DEPARTMENT OF RADIOLOGY

PSG INSTITIUTE OF MEDICAL SCIENCES AND RESEASRCH

PEELAMEDU, COIMBATORE – 641004

TAMILNADU, INDIA

“ROLE OF ULTRASOUND ELASTOGRAPHY IN THE EVALATION OF THYROID NODULES WITH CYTOLOGICAL CORRELATION”

DISSERTATION SUBMITTED TO

THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI

IN PARTIAL FULFILLMENT OF THE REGULATIONS FOR THE AWARD OF DEGREE OF M.D IN RADIODIAGNOSIS.

BY

DR. SUKITHRA.S

GUIDE: DR .DEVANAND.B

DEPARTMENT OF RADIOLOGY

PSG INSTITIUTE OF MEDICAL SCIENCES AND RESEASRCH

PEELAMEDU, COIMBATORE – 641004

TAMILNADU, INDIA

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"ROLE OF ULTRASOUND ELASTOGRAPHY IN THE EVALATION OF THYROID NODULES WITH CYTOLOGICAL CORRELATION**" is the bonafide original work of Dr.SUKITHRA.S .in the department of Radio diagnosis, PSG Institute of Medical Sciences and Research, Coimbatore in partial fulfillment of the regulations for the award of degree of M.D in Radio diagnosis.

SIGNATURE OF THE GUIDE
DR. DEVANAND.B MD
HEAD OF THE DEPARTMENT
DEPARTMENT OF RADIOLOGY
P.S.G IMSR,
COIMBATORE

CERTIFICATE

PSG INSTITIUTE OF MEDICAL SCIENCES AND RESEASRCH

COIMBATORE

This is to certify that the Dissertation work entitled **"ROLE OF ULTRASOUND ELASTOGRAPHY IN THE EVALATION OF THYROID NODULES WITH CYTOLOGICAL CORRELATION "** is the bonafide work of DR SUKITHRA.S in the department of Radiodiagnosis, PSG Institute of Medical Sciences and Research, Coimbatore in partial fulfillment of the regulations for the award of degree of M.D in Radiodiagnosis.

DR. B.DEVANAND
PROFESSOR AND HOD
DEPARTMENT OF RADIODIAGNOSIS
PSG IMS & R
PLACE : COIMBATORE
DATE : 28/9/15

DR.S. RAMALINGAM
PRINCIPAL
PSG IMS & R

ACKNOWLEDGEMENT

Foremost, I would like to express my sincere gratitude to my professor and my guide **DR. B. DEVANAND** for his friendly co-operation which was present throughout the preparation of this work. This work would not have been possible without his guidance, support and encouragement. Dr. B. Devanand will always be a key inspiration to me.

I would like to thank **DR.S. RAMALINGAM** Principal of PSG medical college for providing me with the opportunity and resources to accomplish my research

I would like to thank and express my sincere gratitude to **DR.JAYAPRAKASH.N** Assistant Professor for helping me with the statistical analysis and proof reading, enabling me to complete this study.

I would like to thank my fellow postgraduates and my dear **DR VINU** and **DR SUGANYA** for their immense support during the entire period of my study and for providing me the valuable help and support.

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

May 19, 2014

To
Dr S Sukithra
Postgraduate
Department of Radiodiagnosis
PSG IMS & R
Coimbatore

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 9th May, 2014 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 10.00 am and 11.00 am, and discussed your study proposal entitled:

"Role of ultrasound and elastography in evaluation of thyroid nodules with pathological correlation"

The following documents were received for review:

1. Duly filled application form
2. Proposal
3. Informed consent forms
4. Data collection tool
5. Permission letter from concerned Department Head
6. CV
7. Budget

After due consideration, the Committee has decided to approve the study.

The members who attended the meeting at which your study proposal was discussed are as follows:

Name	Qualification	Responsibility in IHEC	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
Dr P Sathyan	DO, DNB	Clinician, Chairperson	Male	No	Yes
Dr S Bhuvaneshwari	M.D	Clinical Pharmacologist Member - Secretary	Female	Yes	Yes
Dr Sudha Ramalingam	M.D	Epidemiologist Alt. Member - Secretary	Female	Yes	Yes
Dr Y S Sivan	Ph D	Member –Social Scientist	Male	Yes	Yes

The approval is valid for one year.

We request you to intimate the date of initiation of the study to IHEC, PSG IMS&R and also, after completion of the project, please submit completion report to IHEC.

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
INSTITUTIONAL HUMAN ETHICS COMMITTEE

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

PLAGIARISM REPORT FROM TURNITIN.COM

turnitin

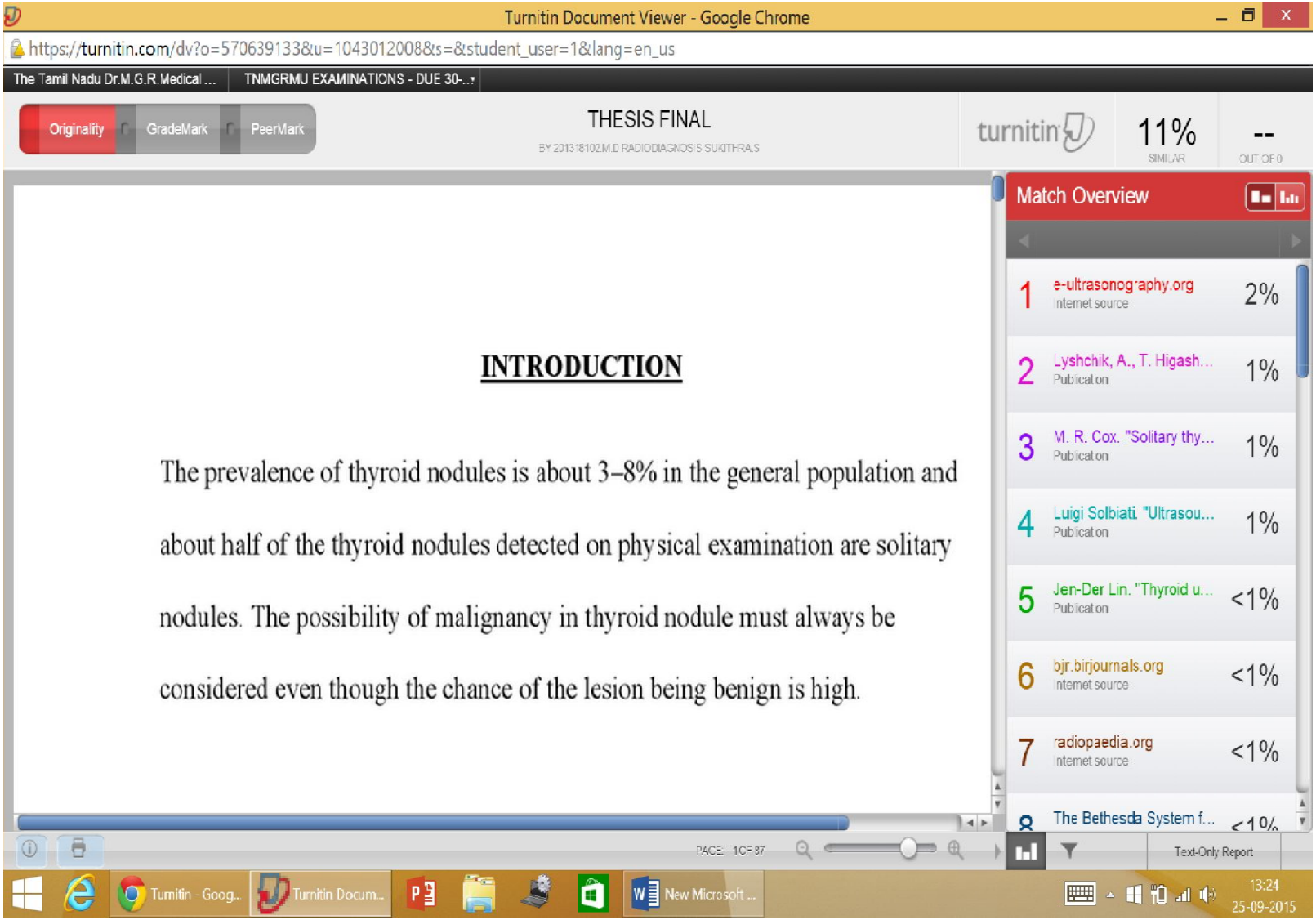
Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	201318102.m.d Radiodiagnosis SU...
Assignment title:	TNMGRMU EXAMINATIONS
Submission title:	THESIS FINAL
File name:	TURNITIN_THESIS.docx
File size:	35.96K
Page count:	87
Word count:	7,547
Character count:	41,747
Submission date:	25-Sep-2015 01:11PM
Submission ID:	570639133

INTRODUCTION


Turnitin Document Viewer - Google Chrome
https://turnitin.com/dv?o=570639133&u=1043012008&s=&student_user=1&lang=en_us
The Tamil Nadu Dr.M.G.R.Medical ...
TNMGRMU EXAMINATIONS - DUE 30-...
Originality
GradeMark
PeerMark
THESIS FINAL
BY 201318102.M.D RADIODIAGNOSIS SUKITHRA.S
turnitin
11%
SIMILAR
--
OUT OF 0
INTRODUCTION
The prevalence of thyroid nodules is about 3–8% in the general population and about half of the thyroid nodules detected on physical examination are solitary nodules. The possibility of malignancy in thyroid nodule must always be considered even though the chance of the lesion being benign is high.
Match Overview
1 e-ultrasonography.org Internet source 2%
2 Lyshchik, A., T. Higash... Publication 1%
3 M. R. Cox. "Solitary thy... Publication 1%
4 Luigi Solbiati. "Ultrasou... Publication 1%
5 Jen-Der Lin. "Thyroid u... Publication <1%
6 bjr.birjournals.org Internet source <1%
7 radiopaedia.org Internet source <1%
8 The Bethesda System f... <1%
PAGE: 1 OF 87
Text-Only Report
Turnitin - Goog...
Turnitin Docum...
New Microsoft ...
13:24
25-09-2015

ABSTRACT

AIM:

- To determine the diagnostic accuracy of high frequency ultrasound in the evaluation of thyroid nodules.
- To assess the efficacy of Elastography in differentiating benign from malignant thyroid nodules
- To explore the sensitivity and specificity of US elastography for differential diagnosis of thyroid cancer with histopathology analysis as a reference standard.

MATERIAL AND METHODS

Prospective study done on thirty patients from May 2014 to March 2015 with complaints of swelling in the neck , difficulty in swallowing and hoarseness of voice who were diagnosed to have solitary thyroid nodules using B mode ultrasound. These patients underwent Sonography, Elastography and Fine needle aspiration. The findings of B-mode and Elastography are correlated with cytology.

RESULTS

- Elastography has a sensitivity of 77.7%, specificity of 91.7%, positive predictive value of 93.3% and negative predictive value of 73.3% in differentiating benign from malignant thyroid nodules.
- Overall diagnostic accuracy of TIRADS in the evaluation of solitary nodule was found to be 81%.

CONCLUSION

High frequency B mode ultrasound is an ideal imaging technique for characterizing solitary thyroid nodules. It is safe because of its non invasive nature and lack of ionizing radiation. B-mode Ultrasound findings along with elastography correlation yields a better diagnosis. Ultrasound elastography seems to have great potential as a new tool for differentiating solid thyroid nodules and recommending site for FNAC

TABLE OF CONTENTS

INTRODUCTION

INTRODUCTION

The prevalence of thyroid nodules is about 3–8% in the general population and about half of the thyroid nodules detected on physical examination are solitary nodules. The possibility of malignancy in thyroid nodule must always be considered even though the chance of the lesion being benign is high.

For the detection of thyroid gland tumors the oldest and most frequently used method is palpation. Generally about 5% of the people predominantly in the adult age group have palpable thyroid gland nodule. On palpation if the thyroid nodule is firm and hard then the rate of malignancy in the nodule is high but as palpation is a highly subjective method the main drawback is dependent on the size and location of the nodule.

For the detection of thyroid gland nodules ultrasound evaluation serves as a very accurate and highly sensitive method but its usefulness is very low in differentiating between benign and malignant thyroid gland tumors.

In patient with thyroid gland nodule the efficient tool for diagnosis of thyroid cancer is fine needle aspiration although it has certain

disadvantage like it is an invasive procedure and subject to sampling and analysis uncertainties.

Elastography is a newly developed noninvasive imaging dynamic technique analogous to manual palpation .Under application of an external force this technique uses ultrasound to provide tissue stiffness by measuring the degree of distortion where stiff tissues deform and exhibit less strain than compliant tissues in response to the same applied force. Ultrasound elastography serves as a added tool to study the hardness/elasticity of nodules in differentiating benign and malignant lesions [(1)]

The aim of our study was to characterize and grade the thyroid nodules using B mode, TIRADS, Elastography and correlate with FNAC.

AIMS & OBJECTIVES

AIM OF THE STUDY

- To determine the diagnostic accuracy of high frequency B-mode ultrasound in the evaluation of thyroid nodules.
- To assess the efficacy of Elastography in differentiating benign from malignant thyroid nodules
- To explore the sensitivity and specificity of US elastography for differential diagnosis of thyroid cancer with FNAC analysis as a reference standard.

MATERIALS AND METHODS

MATERIALS AND METHODS

Prospective study done on thirty patients with complaints of swelling in the neck, difficulty in swallowing and hoarseness of voice who were diagnosed to have solitary thyroid nodules using B mode ultrasound.

The duration of the study was from May 2014 to March 2015.

All the thirty patients underwent Sonography, Elastography and Fine needle aspiration. The findings of B-mode and Elastography are correlated with cytology.

B mode Ultrasound of the thyroid gland was performed with a SIEMENS ACUSON S2000 using high frequency probes 9L4 and 14L5 with patients in supine position and extension of the neck.

The lesions were categorized using **Thyroid image reporting and data system (TIRADS)** scoring system. [2]

TABLE 1:

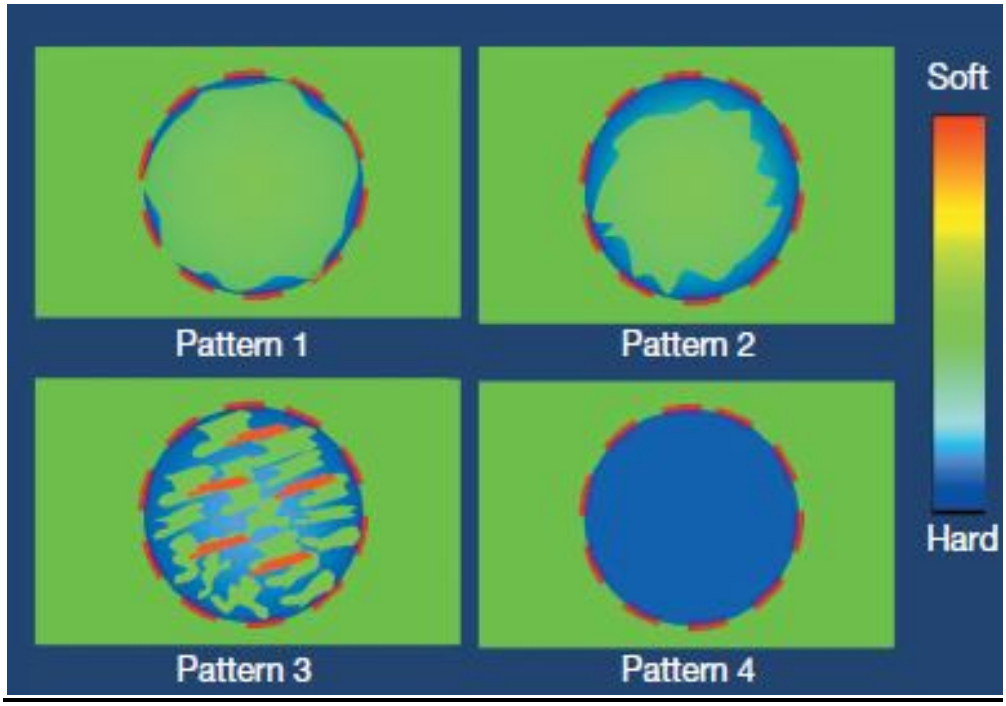
TIRADS 1	NORMAL THYROID GLAND
TIRADS 2	BENIGN LESIONS
TIRADS 3	PROBABLY BENIGN LESIONS OR LOW RISK MALIGNANT LESIONS
TIRADS 4	LESIONS WITH INCREASING RISK OF MALIGNANCY
TIRADS 5	MALIGNANT LESIONS

Ultrasound Elastography was performed with SIEMENS ACUSON S2000 at the same time as the B mode examination. The probe is placed over the region such that the lesion is in the centre of the image, holding the scan plane perpendicular on the skin surface. The ROI is selected in the way that the lesion should not be more than 25%. At least a 5 mm of normal adjacent tissue should be included, to assess the lesion stiffness in relation with the average elasticity of the surrounding tissue. The targeted lesion was scored as 1 to 4, using strain elastographic scores proposed by Asteria et al [(3)]

TABLE 2:

Score of 1	ELASTICITY IN THE ENTIRE EXAMINED AREA.
Score of 2	ELASTICITY IN A LARGE PART OF THE EXAMINED AREA.
Score of 3	STIFFNESS IN A LARGE PART OF THE EXAMINED AREA.
Score of 4	NODULE WITHOUT ELASTICITY.

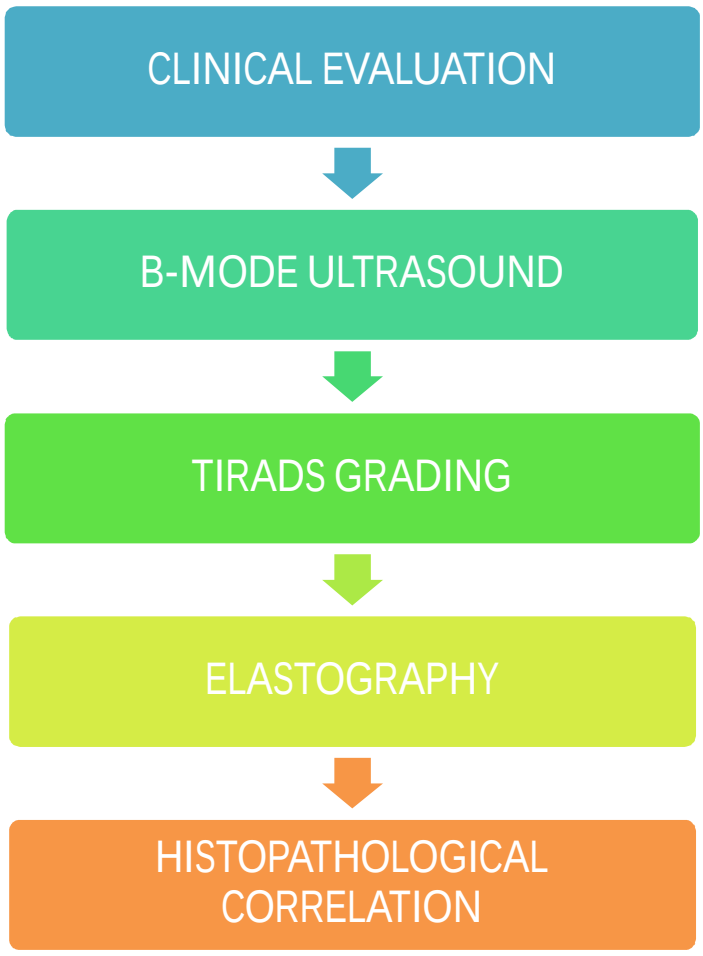
FIGURE 1: DIAGRAMATIC REPRESENTATION OF THE ELASTOGRAPHIC SCORES PROPOSED BY ASTERIA ET AL [3]



Ultrasound guided FNAC was done using 22-gauge needle and the lesion was aspirated at least twice with the freehand technique. Samples that were obtained were expelled on glass slides and they are smeared. Slides are dried and few slides are placed immediately in 95% alcohol for Papanicolaou staining.

DATA PLAN

STUDY DESIGN: PROSPECTIVE STUDY



INCLUSION CRITERIA:

- Patient having focal nodule in thyroid.
- Patients undergoing B-mode ultrasound, elastography and FNAC of the nodules.

EXCLUSION CRITERIA:

- Diffuse thyroid enlargement with no focal lesion.
- Multiple nodules in thyroid gland.
- Not willing for FNAC

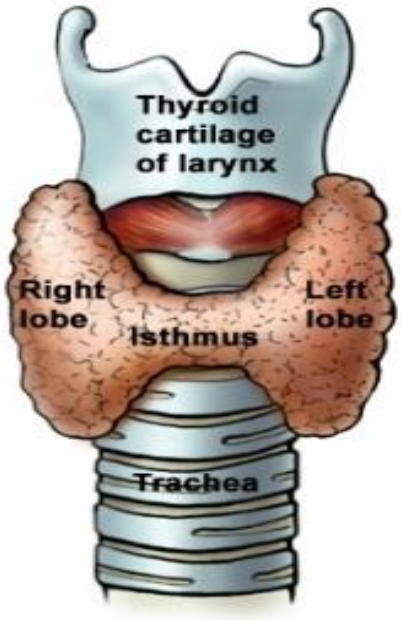
REVIEW OF LITERATURE

REVIEW OF LITERATURE

ANATOMY

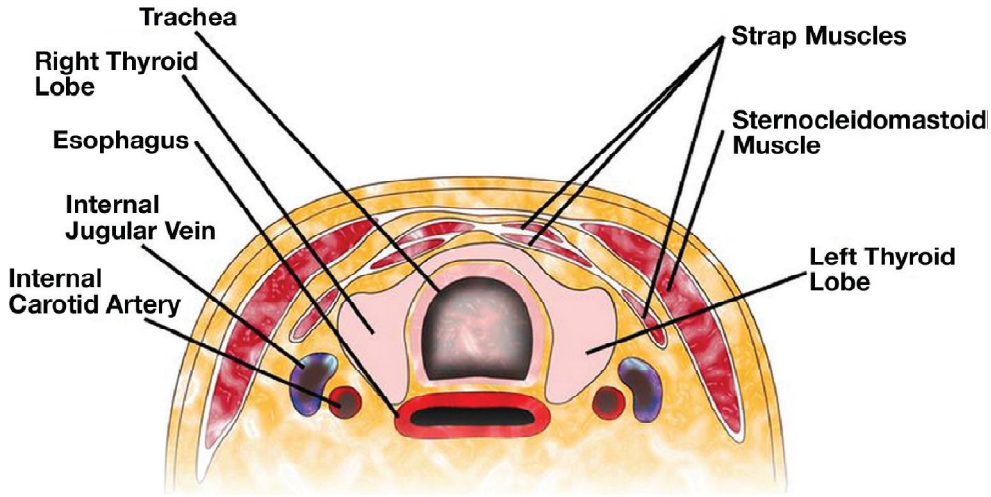
The thyroid gland lies in the visceral space extending from C5 – T1 level. It is butterfly or H-shaped bi-lobed structure which is connected anteriorly by a thin rim of thyroid tissue known as the isthmus, located just below the laryngeal cartilage. The internal carotid arteries and internal jugular veins are located posterolateral to the thyroid lobes, whereas the strap muscles of the neck are located anteriorly

FIGURE 2(A) : ANATOMY OF THYROID GLAND



:

FIGURE 2(B)



BLOOD SUPPLY

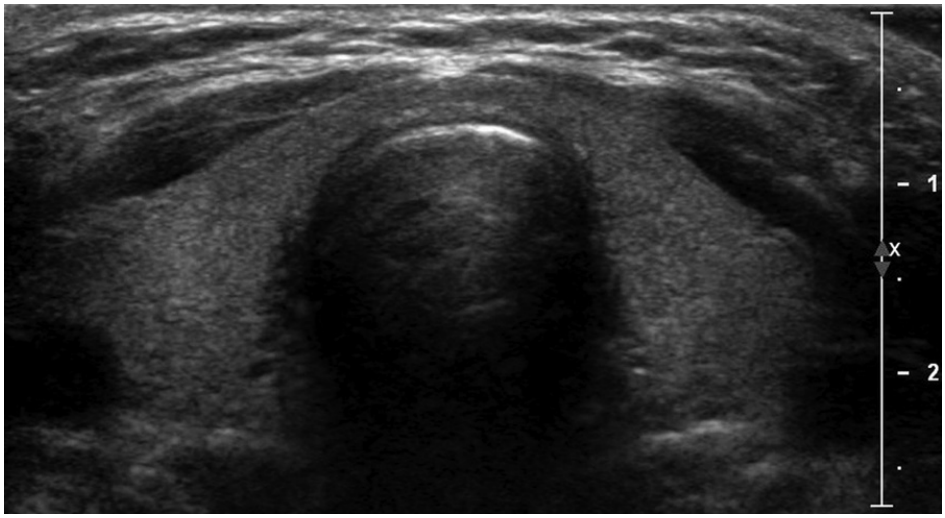
- Arterial supply to the thyroid gland is from the
  - Superior thyroid artery which is a branch of external carotid artery and
  - Inferior thyroid artery from thyrocervical trunk
- Venous drainage from the thyroid gland is through superior, middle and inferior thyroid veins.
  - Superior thyroid vein and middle thyroid vein drains to internal jugular vein.
  - Inferior thyroid vein drains to brachiocephalic vein.

IMAGING APPEARANCE

On ultrasound the thyroid gland appears as homogenously medium to high level Echogenicity.[7]

Each thyroid lobe normally measures 4-7 cm in length, <2 cm in depth. Isthmus measures <0.5 cm in depth.

FIGURE 3: ULTRASOUND APPEARANCE OF NORMAL THYROID GLAND



OVERVIEW OF THYROID LESIONS – B –MODE

SONOGRAPHICAL FEATURES

A thyroid nodule is defined as a discrete lesion within the thyroid gland that is sonographically distinguishable from the surrounding thyroid parenchyma. For each thyroid nodule gray-scale and color Doppler US are used to evaluate the following

- Size,
- Shape
- Location within the Thyroid gland
- Composition,
- Echogenicity,
- Regularity of the border or margin around the nodule,
- Presence of a halo,
- Vascular pattern and
- Calcifications

Size:

The size of the nodule should be documented for follow-up Size of the thyroid nodule is calculated by the three dimensional measurements - width, depth, and length.

Based on this ultrasound can accurately assess the change in the size of thyroid nodules during follow up. [4]

Shape:

It is proven in previous studies that taller-than-wide shape has diagnostic importance for differentiating benign thyroid nodules from malignant thyroid nodules.The nodule can be classified as taller than wide shape if the anteroposterior diameter of a nodule is equal to or less than its transverse diameter on a transverse or longitudinal plane. [4]

Composition:

Composition of a thyroid nodule is classified as

- solid,
- mixed solid and
- cystic

Most thyroid nodules are solid or have a predominantly solid component. The cystic fluid inside the complex nodules represents degeneration and possible hemorrhage Pure cystic thyroid nodules are very rare lesions they are usually benign and do not possess the risk of malignancy[4]

Large cystic component favour's a benign entity even though there is a significant proportion that the papillary carcinomas will have a cystic component while a halo around a well-marginated hypoechoic or isoechoic nodule is typical of a follicular adenoma. [4]

Echogenicity:

Echogenicity of the solid portion of thyroid nodules is usually assessed in comparison to the thyroid parenchyma and surrounding neck strap muscles.

Echogenicity is classified as

- Hyperechoic,
- Isoechoic,
- Hypoechoic, Or Marked Hypoechogenicity.

Hypoechoic nodules include the majority of the malignant nodules mostly papillary thyroid carcinomas and nearly all medullary thyroid carcinomas and nearly 50 % of the benign nodules Compared to hypoechogenicity marked hypoechogenicity serves as a more specific and more reliable criterion for malignant thyroid nodules.If the nodule appears Isoechoic then there is 25% chance the lesion can be follicular or medullary carcinoma. [4] If the nodule appears hyperechoic then the nodule has 5% chance of being malignant [4]

Halo sign:

A rim around the nodule could be seen with benign or malignant conditions. Hypoechoic or sonolucent rim surrounding the nodule are usually thought to represent the compressed perinodular vessels.Benign nodules grow slowly over a period of time so it is assumed that they displace the peripheral vasculature as they increase in size which results in the formation of thin halo, but is less common in malignancy. However, a thick, irregular halo is more suggestive of a neoplasm (capsulated lesions-follicular or Hurthle cell carcinoma or adenoma) [4]

Calcification:

Calcification are categorized as

- Microcalcifications
- Macrocalcifications

Calcification can be seen in both benign and malignant condition.Microcalcifications are defined as calcifications that are equal to or less than 1 mm in diameter and they are visualized as tiny punctate hyperechoic foci without posterior acoustic shadowing and is the most specific finding associated with malignancy associated with papillary thyroid carcinoma .Macrocalcifications are defined as hyperechoic foci

larger than 1 mm with posterior shadowing and they are associated with both papillary thyroid carcinoma and medullary thyroid carcinoma.[4].

Borders:

Margins are classified as

- Well-Defined
- Irregular [32]

Benign lesions have well defined borders where as some malignant nodules have a predominately regular border, but may have irregular border in only small portion. Thus the margins and the halo should be followed all through the nodule. Malignant nodules have irregular margins as they have the tendency to invade the surrounding thyroid parenchyma. [4]

Doppler Findings:

It is suggested that increased blood flow in the central part of a nodule is more likely to be associated with malignancy than the peripheral vascularity.Perinodular blood flow is usually seen in benign nodules, but some of malignant nodules also show perinodular blood flow. [4]

TABLE 3: DIFFERNTIATING FEATURES BETWEEN BENIGN AND MALIGNANT NODULES

MALIGNANT	BENIGN
HYPOECHOGENGIC	HYPERECHOIC
IRREGULAR MARGINS	SMOOTH MARGINS
MICRO CALCIFICATION	EGG SHELL CALCIFICATION
INCREASED INTRANODULAR FLOW	ABSENT OR PERIPHERAL VASCULARITY
THICK IRREGULAR HALO	THIN HALO
TALLER THAN WIDE	WIDE THAN TALL
SIGNIFICANT INCREASE IN SIZE OVER TIME	DECREASE IN SIZE
ABNORMAL CERVICAL LYMPHADENOPATHY WITH LOSS OF FATTY HILUM	NORMAL , SMALL REACTIVE NODES WITH MAINTAINED FATTY HILUM

PATHOLOGY OF SOLITARY THYROID NODULES

BENIGN LESIONS:

- **BENIGN FOLLICULAR NODULE**
- **ADENOMATOID NODULE**
- **COLLOID NODULE**
- **FOLLICULAR ADENOMA**
- **HURTHLE CELL ADENOMA**

MALIGNANT LESIONS:

- **PAPILLARY CARCINOMA**
- **FOLLICULAR CARCINOMA**
- **MEDULLARY CARCINOMA**
- **ANAPLASTIC CARCINOMA**
- **LYMPHOMA**
- **METASTASIS**

BENIGN THYROID LESIONS

BENIGN FOLLICULAR NODULE

Benign follicular nodules are composed predominantly of colloid and benign-appearing follicular cells in varying proportions which include

- Adenomatoid Or Hyperplastic Nodules,
- Colloid Nodules,

An **adenomatoid or hyperplastic** nodule is a non neoplastic lesion composed of follicles, colloid, and variable amounts of fibrosis and is generally an unencapsulated. Although it may be solitary, this nodule is usually found in the setting of multinodular goiter. On ultrasound hyperplastic nodules are isoechoic / hypoechoic and they undergo cystic and haemorrhagic degeneration. Degeneration produces dystrophic calcification and manifest as coarse internal calcification or peripheral egg shell calcification.

A **colloid nodule** is a benign lesion composed primarily of colloid and scant follicular cells At US, colloid nodules are well marginated and hyperechoic .A thin, regular sonolucent halo may be seen. Degenerative and hemorrhagic .A thin, regular sonolucent halo may be seen.

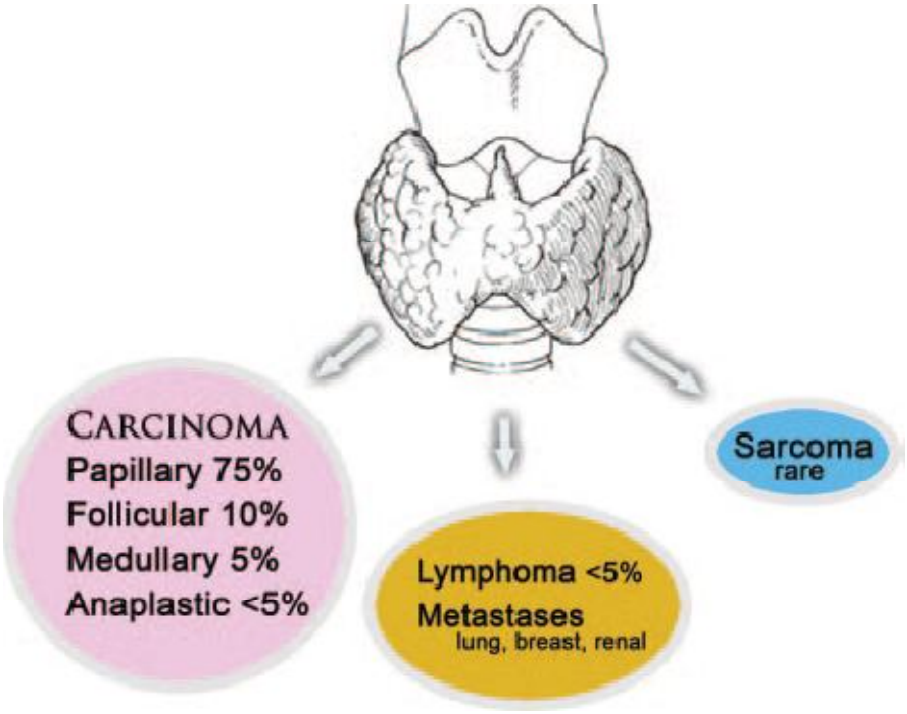
Degenerative and hemorrhagic changes are common. Perinodular blood vessels are easily detected with Doppler Sonography. The nodule may be associated with calcification, which is often coarse and perinodular.

FOLLICULAR ADENOMA.

Follicular adenoma is a benign neoplastic proliferation of follicles surrounded by a complete capsule. When a nodule is reported to be a follicular neoplasm at FNAC, there is a 70%–85% chance of its being a follicular adenoma and a 15%– 30% risk of malignancy Hurthle cell adenoma is considered a variant of follicular adenoma in which over 75% of cells shows oncocytic or Hurthle cell changes. On ultrasound they are usually solitary encapsulated nodule with a well defined peripheral hypoechoic halo.

MALIGNANT THYROID LESIONS

FIGURE 4: FREQUENCY OF THE DIFFERENT TYPES OF THYROID MALIGNANCY.



(5)

PAPILLARY CARCINOMA

Papillary carcinoma are composed of follicular cells with distinctive nuclear features and represents 80% of all primary thyroid malignancies and frequently has nodal metastases at presentation. It occurs more often in young females with a mean age of 35 years.Papillary carcinoma appears on ultrasound as a solitary mass located in subcapsular region with hypoechoic, solid component, an irregular outline, intra nodular vascularity. Small punctate regions of

echogenicity representing microcalcifications (psammoma bodies) may be present within the lesion & cervical lymph node metastases. The prognosis for papillary carcinoma is generally very good

FOLLICULAR CARCINOMA.

Follicular carcinoma is a malignant neoplasm composed of follicular cells with capsular or vascular invasion. It represents 10% of all primary thyroid malignancies . Both follicular carcinomas and follicular adenomas are reported as follicular neoplasm or suspicious for follicular neoplasm at FNAC. The prognosis for follicular carcinoma is generally good As with papillary carcinoma, factors indicating a poor prognosis include patient age greater than 45 years and advanced tumor stage Sonological characteristics of follicular carcinoma appears as irregular margins, thick irregular halo and a tortuous or chaotic arrangement of internal blood vessels.

Hurthle cell carcinoma which is a variant of follicular carcinoma in which over 75% of cells show oncocytic or Hurthle cell changes, accounts for 3% of all primary thyroid malignancies The prognosis for Hurthle cell carcinoma is intermediate and is worse than that for follicular carcinoma Poorly differentiated carcinoma can be considered a variant of follicular carcinoma in which there is often an insular growth pattern and nuclear features of a higher-grade malignancy

ANAPLASTIC CARCINOMA.

Anaplastic (undifferentiated) carcinoma is a highly malignant neoplasm with unequivocal features of a high-grade carcinoma. It accounts for <5 % of all primary thyroid malignancies and carries a poor prognosis. As this lesion has a wide local invasion surgery is usually not an option with anaplastic carcinoma. It usually occurs in elderly patients with a mean age of 60 years. On ultrasound these lesions usually appears hypoechoic with invasion of the blood vessels and the adjacent and neck muscles.

MEDULLARY CARCINOMA.

Medullary carcinoma is a malignant neoplasm derived from thyroid neuroendocrine C cells that secrete calcitonin. It represents 5% of all primary thyroid malignancies. Typically patients present with a painless palpable nodule in the 5^{th} and 6^{th} decade of life, but the disease is often metastaic to cervical lymph node at presentation. Slight female predominace.On ultrasound medullary carcinoma are typically solid , hypoechoic and have a coarse central calcification.

THYROID LYMPHOMA

Accounts for <5% of all thyroid malignancies and it is more common in females. On ultrasound these lesion appears as lobulated hypoechoic area with central necrosis, adjacent thyroid parenchyma also appears heterogeneous .the adjacent vessels may also be involved in certain cases.

THYROID IMAGE REPORTING AND DATA SYSTEM (TIRADS) SCORING SYSTEM

TI-RADS 1 –

Normal thyroid

TI-RADS 2-

Benign sonographic features: simple cysts, central cyst, nodules with homogeneous peripheral calcification, spongiform nodule.

TIRADS 3-

(Benign /low probability of malignancy).

Hyperechoic with or without small cystic abnormalities, Solid with peripheral vascularity and a mixed pattern of hypo, iso or hyperechoic spots and/or small cystic changes and/or macrocalcifications

SONOGRAPHICALLY SUSPICIOUS CRITERIA FOR MALIGNANCY

- Hypoechogenicity
- Microcalcifications
- Partially cystic nodule with eccentric location of the fluid portion and lobulation of the solid component

- Irregular margins
- Perinodular thyroid parenchyma invasion
- Taller-than-wide shape
- Intranodular vascularity
- Lymph node involvement

TI-RADS 4:

TI-RADS 4a:

when they had one feature from the sonographically suspicious criteria for malignancy

TI-RADS 4b:

when they two features one feature from the sonographically suspicious criteria for malignancy

TI-RADS 4c:

when they had three to four features from the sonographically suspicious criteria for malignancy

TI-RADS 5 :

when they had five features from the sonographically suspicious criteria for malignancy [(2)]

ELASTOGRAPHY TECHNIQUES

STRAIN ELASTOGRAPHY

- Strain elastography is also known as static elastography which requires an external palpation with a probe.
- The elastographic image is acquired by continuous compression followed by decompression of the transducer.
- After compression the deformed tissue due to stress is measured.
- The image is visualized in a split-screen mode where there is both B-mode image and an elastogram on the screen.
- The elastic image is superimposed on the B-mode image, and the tissue stiffness is displayed from red to blue colour which indicates soft tissue to harder tissues following which the visual scoring of the colours within the nodules and around the nodules are assessed using various scoring system.[3]

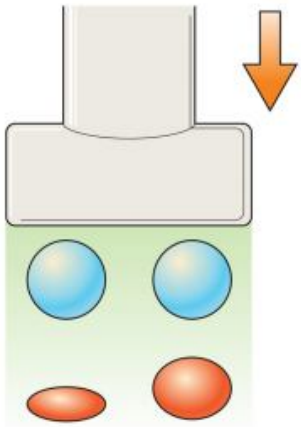


FIGURE 5: Principle of strain elastography which evaluates elasticity through tissue displacement caused by compression, with the degree of displacement being larger in soft tissue than in hard tissue

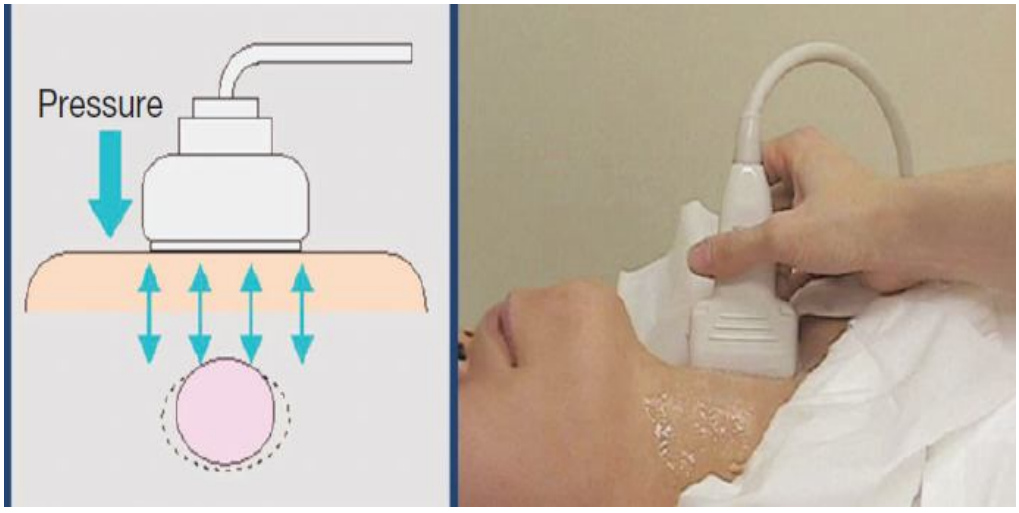


FIGURE 6: Scanning method of elastography

- **Quality Factor** – Appears at the bottom of the screen to assist the examiner in choosing optimal images for review. It gives information about the adequacy of the compression used.

- **Elastographic Maps** –Elastographic maps are colour coded images depicting the tissues' relative hardness and softness.

- **Shadow Measurements** – Measurement calipers are displayed side-by-side automatically on both the B-mode and Elastographic image. This helps in comparison.

REVIEW OF LITERATURE

Yamakawa et al[8] (1966) demonstrated that by using ultrasound the size of the thyroid gland can be estimated.

Fujimoto et al[9] (1968) suggested that ultrasound could be used to distinguish benign from malignant masses of thyroid.

Blum et al (1972)[10] demonstrated that hemorrhagic and degenerated areas in a solid nodule could be seen as mixed echogenicities on B-scan.

Zachrissonet al[13] (1976), discovered that vascularity was a useful criteria for predicting the malignant and benign nature of thyroid disease. The latter years saw the development of color Doppler where Doppler information could be superimposed on cross sectional images thus showing soft tissue and color flow at the same time.

W.S. Chilcote et al[22](1976), described the normal internal architecture of the thyroid as being 'FINE' homogenous echo pattern of a medium grey tone.

Sackler, Passalaqua AM (1977), were the first to describe the sonographic appearances of a spectrum of thyroid disease, using grey scale B scanner and a 3.5 MHz transducer. [(11)] Nodules were classified as

solid-discrete and non discrete, cystic-simple and hemorrhagic; and complex - hemorrhagic and necrotic.

Focal diseases include adenomatous hyperplasia, thyroid adenomas, cysts, primary malignancies, focal thyroiditis and less commonly lymphoma, metastases, granulomas and abscess.

The primary malignancies include papillary carcinoma, follicular carcinoma including clear and Hurthle cell types, anaplastic carcinoma, medullary carcinoma, epidermoid, mucinous carcinoma and metastases.

Sonographic anatomy was better described with high frequency probes of 7.5 mHz and 10mHz **by Simeone et al**, (1982).[12]

JF Katz et al[14] (1984)demonstrated the various sonographic patterns of thyroid disease in correlation with pathologic findings, using high frequency ultrasound. They also found that ultrasound is very accurate in detecting architectural variation, adenomatous goitre and solitary nodules.

Walter J et al (1985)[16] conducted a prospective study in which 200 patients with clinically solitary nodule were investigated by ultrasound examination and then these nodules underwent surgery. Then comparison between the ultrasound and ultimate pathological findings in 101 patients who underwent surgery was done which showed that nearly

50% of patients with a clinically solitary thyroid nodule were benign and they could have avoided surgery.

In **1985, solbiati et al** stated that simple cystic lesions are unlikely to be malignant, but lesion with both solid & cystic components have a 11% chance of malignancy which may be papillary, follicular or metastatic.[15]Predominantly hypoechoic nodules, incompletely & irregularly thickened halo (greater than 2mm) and irregular, poorly defined margins were indicative of malignancy.[15]

Hayashi et al[23] (1986) stated that thyroid malignancies do not have a pathognomic appearance on Ultrasound.

Regarding lymphnode involvement, according to **Hajeck et al [1986]** 5 mm was proposed to be the upper limit of normal cervical nodes & no metastases were found in nodes of smaller size.[25]

Invasions of surrounding structures, though occurring in less than 10% of neoplasms, was pathognomic of malignancy. Carotid artery invasion was suggested by hypoechogenecity of its walls as was stated by **Gooding et al, in 1989**.[24]

In a study conducted by **M.R.cox et al in 1991**[17] it was found that ultrasound examination of the thyroid suggested correctly that one of the 16 cystic lesions, 4 of the 16 complex solid-cystic lesions and 3 of the 18

solid lesions were malignant. They also found that one lesion reported as multinodular goiter on ultrasound and one reported as normal also turned out to be malignant. They concluded that ultrasound does not differentiate benign from malignant conditions accurately and recommended that the routine use of ultrasound in the investigation of solitary thyroid nodule should be abandoned.

Micro calcifications were almost exclusively found in malignancies. These could be detected as hyperechoic dots of less than 2mm with or without posterior shadowing. According to **Takashima S et al (1995),** they showed a specificity of (93%) for malignancy. However, its sensitivity is low (36%) and insufficient to be reliable for detection of malignancy[44]. Microcalcifications are due to psammoma bodies in papillary cancers while they are attributed to calcifying amyloid in medullary carcinomas.

Solbiatiet al[15] (1995) demonstrated that 70 to 90% of thyroid malignancies display internal vascularity with or without a peripheral component. He also showed the reliability of sonographic features in the differentiation of benign from malignant thyroid nodules.[15]

TABLE 4:

Pathologic Diagnosis		
FEATURE	**BENIGN**	**MALIGNANT**
Internal contents:	++++	
Purely cystic content	++++	+
Cystic with then septa	+++	+
Mixed solid and cystic	+++	++
Comet-tail artifact		+
Echogenicity:	++++	
Hyperechoic	+++	+
Isoechoic	+++	++
Hypoechoic		+++
Halo:	++++	
Thin halo	+	++
Thick incomplete halo		+++

	+++	
Margin:	++	++
Well defined		+++
Poorly defined	++++	
Calcification:	+++	+
Eggshell calcification	++	+
Coarse calcification		++++
Microcalcification	+++	
Doppler:	++	++
Peripheral flow pattern		+++
Internal flow pattern		

+ = rare (<1%)

++ = low prabablity (<15%)

+++ = intermediate probability (16%to84%)

++++ = high probablilty(>85%)

Eisuke Koike et al[10] (1999) designed a retrospective study of 329 thyroid nodules, to assess the role of high frequency ultrasound in prediction of malignancy. Ultrasound characteristics were compared with pathological results. Results showed a sensitivity and specificity of 86.5% and 92.3% respectively for ultrasound diagnosis of non follicular neoplasms and 18.2% & 88.7% for follicular neoplasms.

Ellen Morqusee et al (2000)[18], performed a study to evaluate the role of routine ultrasonography in the management of nodular thyroid disease. Among 50 of the 114 patients referred for a solitary nodule, ultrasound detected additional non palpable nodules of atleast 1 cm in diameter in 27 patients. Aspiration was not required in 23 patients as the nodules were small in size. They results confirmed that ultrasound altered the clinical management in 63% of patients with thyroid nodules.

Heged C et al[19] 2001, in their review study have mentioned that although ultrasound lacks specificity for tissue diagnosis and can rarely distinguish benign from malignant disease ultrasound can be used to give aaccurate estimation of the size of the thyroid gland ,the tissue desity, detecting the vascular flow and also identify the regional lymphadenopathy. It also aids in accurate placing of needles for diagnostic and therapeutic purposes. In addition ultrasound is aasfe procedure as it does not involve ionizing radiation.

Papini E et al (2001)[20]in their study establishes the relative importance of ultrasound features as risk factors of malignancy, in 195 patients with solitary nodule, of which 18 were malignant. At ultrasound, malignant lesions presented as solid hypoechoic lesions in 87% of cases, irregular or blurred margins in 77%, an intranodular vascular pattern in 74% and microcalcification in 29%.These factors were considered as independent risk factors for malignancy.

Giammancoet al[21] **(2002),** demonstrated that there was a significant reduction in false positive or false negative cases after the integration of color Doppler with B-mode.

Horvath et al. demonatrated that the thyroid nodules can be classified TIRADS based on the patterns of nodules. This was simplified by **Kwak et al.** who proposed nodules categorization into TIRADS based on the number of the ulatrasound features that were suspicious for malignancy He also suggested the maliganancy rate increased as the ultrasound suspicious features increased.(32)

J. Fernández Sánchez et al **(29)** demonatrated that ultrasound features suspicious for malignancy can be scored based on TIRADS scoring system which can be applied in daily practice.The result obtained based on the scoring system was 0 in TIRADS 2 and TIRADS 3 for

benign lesions and 2.2% of the thyroid nodule were malignant.TIRADS 4 the malignancy rate was 85% and in TIRADS 5 the malignancy rate was 100% in this study

Based on the criteria for malignancy and the score assigned in this study, the probability of malignancy for TNs with a score of 1 is 10%, while for those with a score of 2 is almost 50% and for those that have been assigned a score of 3 or 4, the probability of malignancy is 85%. All TNs with a score of 5 or higher are malignant. A TI-RADS classification based on the scoring system described above should allow for and lead to unification of terminology and codes for TN classification among all physicians who evaluate the results of a thyroid ultrasound.

Jin Young Kwak[3] demonstrated that elastography of the thyroid nodule was 1st reported by Rago et al which where based on ueno and itoh study he used five-point scoring system using strain elastography. He defined if there was elasticity in the entire nodule then a score of 1 was given, Score of 2 if the nodule was predominantly soft, score of 3 if the nodule was peripherally soft, score of 4 if the nodule was entirely hard and score of 5 if the area under consideration as well as the entire nodule appears hard.

Asteria et al. in 2008 proposed four-point scales based on the study done by Itoh et al. Asteria's criteria defined a score of 1 if the nodule was entirely soft, score of 2 if the nodule was predominantly soft, score of 3 if the nodule was predominantly hard and score of 4 if the nodule was entirely hard.

Thus from their study it was found that malignant lesion were given to Asteria score 3 or 4 and rago score of 4 and 5. Benign lesions were given Rago score of 1,2 and 3 and Asteria score of 1 and 2.

DIAGNOSTIC ACCURACY OF ULTRASOUND AND FINE NEEDLE ASPIRATION CYTOLOGY IN THE EVALUATION OF THYROID NODULE

Campbell & Pillsbury (1989)[6], evaluated the results of nine different studies in which 912 patients on whom FNAC was performed ultimately underwent surgery. The results translated to an over all accuracy of over 95%.[6]

Jones AJ et al (1990)[27], following their study of 175 patients, demonstrated that sensitivity, specificity and positive predictive value of FNAC for thyroid cancer was 92%, 85%, & 41 % respectively as compared with 75%, 61%, and 19% for ultrasound. They inferred that

FNAC should be considered as the initial investigation as it gives adequate information for the management.

Lin JD et al in 1993[28] retrospectively reviewed 3657 patients who underwent ultrasound examination with FNAC. They emphasized that thyroid ultrasonography with FNAC could provide high specificity & sensitivity in differentiating malignant lesions from benign.

Okamato et al in (1994)[26], conducted a retrospective study to determine the reliability of physical examination, ultrasound & FNAC in the evaluation of thyroid nodule. In this study, the specificity of physical examination, ultrasound and FNAC for malignancies was 98%, 90% and 98% & sensitivity was 63%, 78% and 80% respectively.

The accuracy of FNAC in making a diagnosis of thyroid cancer was greater than 90% according to a study conducted by **Goepfert et al, in 1998.**

Currently, thyroid FNAC is used worldwide and is considered an essential step in the work-up of thyroid nodules.

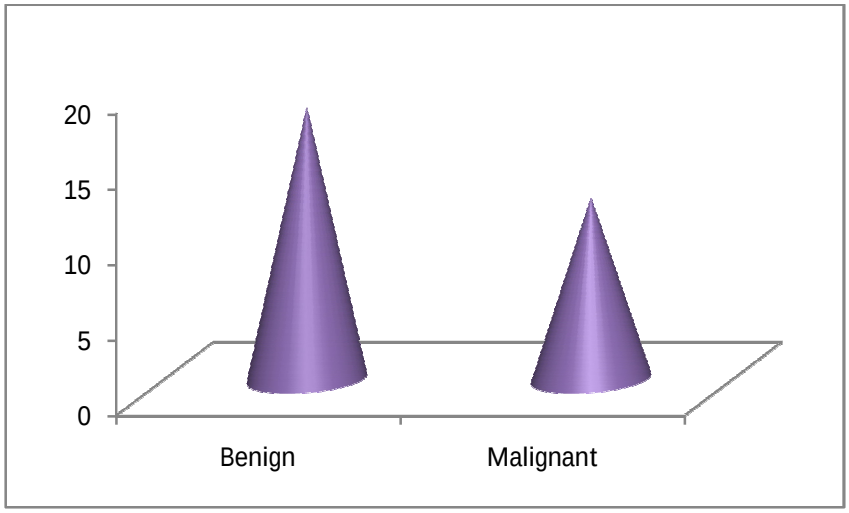
OBSERVATION AND RESULTS

OBSERVATION AND RESULTS

In this study 30 patients were evaluated with Ultrasonography and Elastography, the findings of individual modalities were compared with the cytological findings.

1. In the study population, 18 (60%) lesions were benign and 12 (40%) lesions were malignant .

FIGURE 7:DISTRIBUTION OF TYPES OF LESIONS



2. Out of the 12 malignant lesions, 7 (58.3%) were papillary carcinoma, 4 (33.3 %) were follicular carcinoma and 1 (8.3%) was medullary carcinoma.
3. Out of the 18 benign lesions, 13 (72.2%) were colloid nodule , 4(22.2%) were adenomatoid nodule and 1(5.6%) was follicular adenoma.

TABLE 5:

DISTRIBUTION OF DIFFERNENT TYPES OF BENIGN LESIONS

BENIGN	FREQUENCY	PERCENTAGE
FOLLICULAR ADENOMA	1	5.6
ADENOMATOID NODULE	4	22.2
COLLOID NODULE	13	72.2
TOTAL	18	100

FIGURE 8:

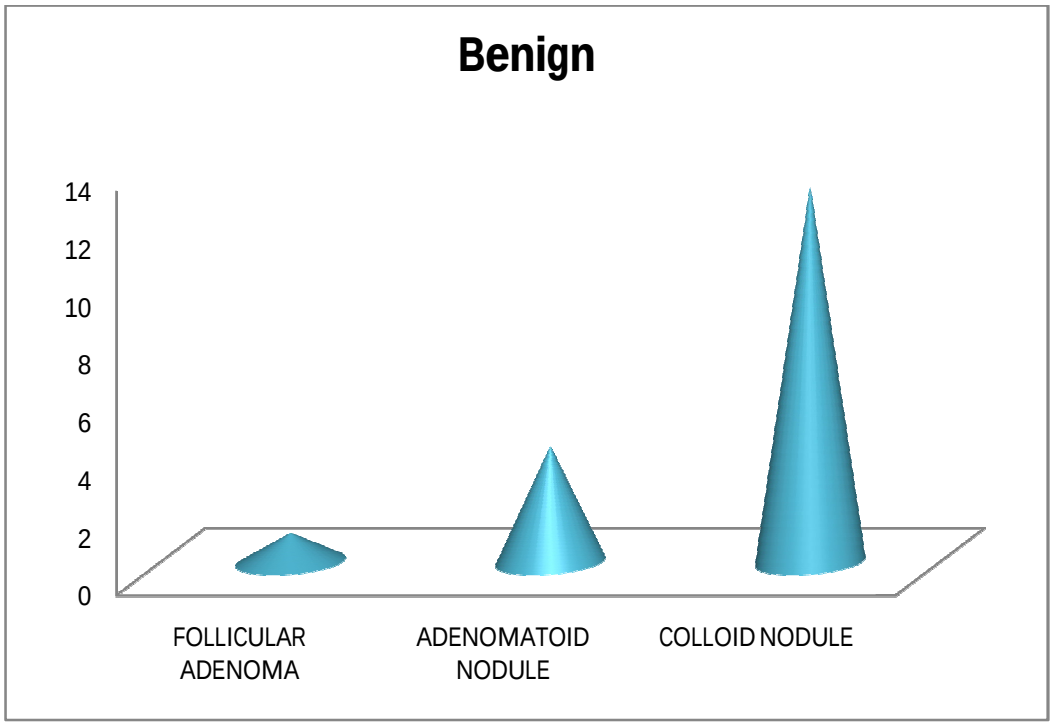


TABLE: 6 DISTRIBUTION OF DIFFERENT TYPES OF MALIGNANT LESIONS

MALIGNANT LESIONS	FREQUENCY	PERCENTAGE
PAPILLARY	7	58.3
FOLLICULAR	4	33.3
MEDULLARY	1	8.3
TOTAL	12	100

FIGURE 9 :

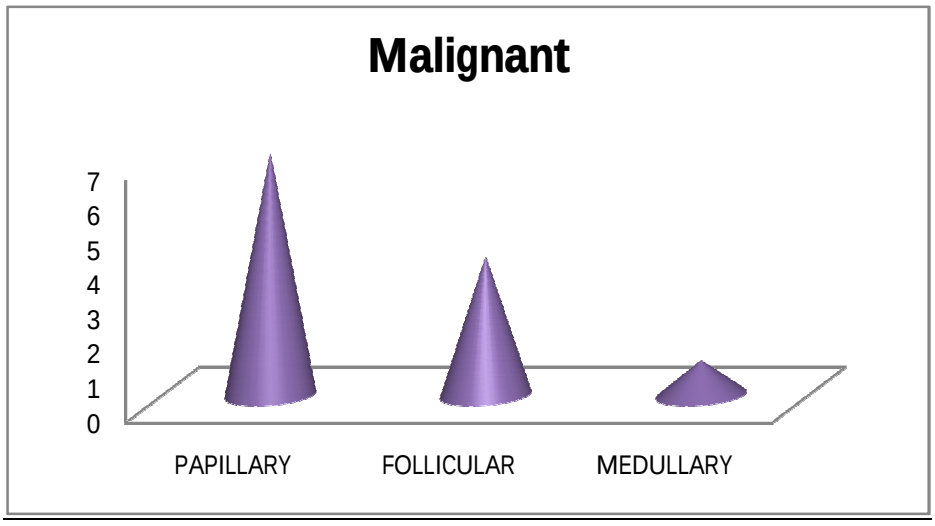


TABLE 7: AGE DISTRIBUTION

AGE	BENIGN	MALIGNANT	TOTAL NO OF CASES	PERCENTAGE OF AGE DISTRIBUTION
<30 YRS	2	1	3	10
30 - 40	5	3	8	26.7
40 - 50	6	1	7	23.3
>50	5	7	12	40
TOTAL	18	12	30	100

FIGURE 10 :

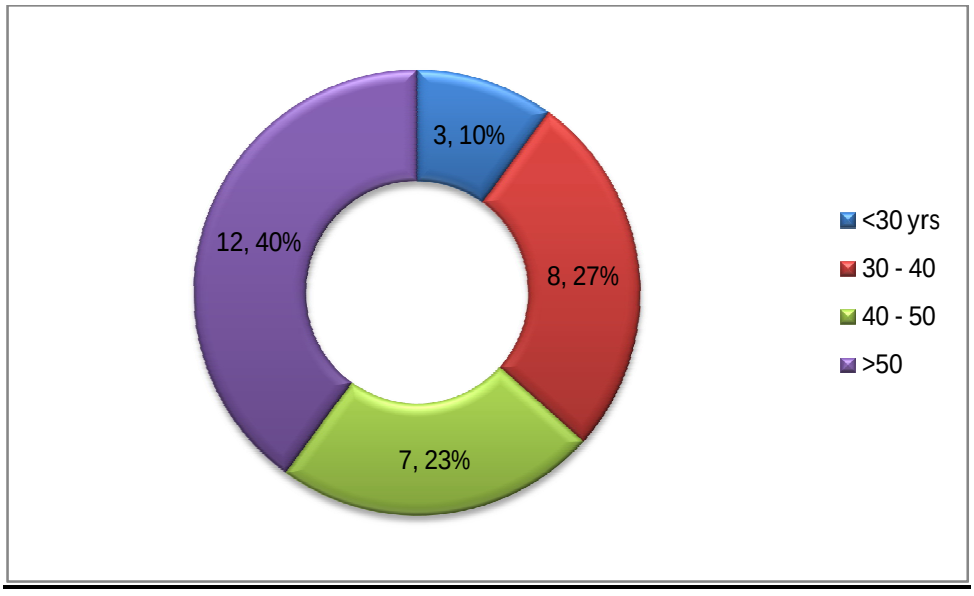
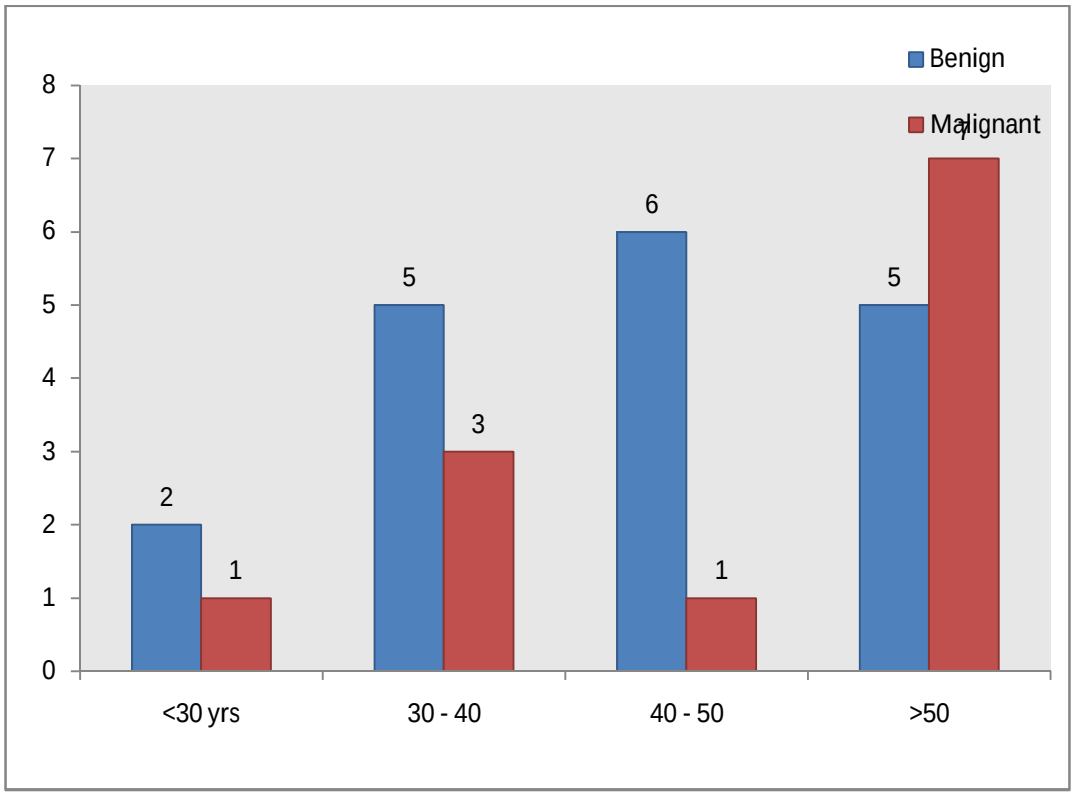


FIGURE 11: AGE WISE DISTRIBUTION OF BENIGN AND MALIGNANT LESION:



In our study population the mean age of study population for malignancy was above 50 years and for benign lesions was found to be between 30-50 Years and the majority of the cases was females (83.3%) and only the remaining (16.7%) was males.

TABLE 8 SEX INCIDENCE

SEX	FREQUENCY	PERCENTAGE
MALE	5	16.7
FEMALE	25	83.3
TOTAL	30	100

FIGURE 12:

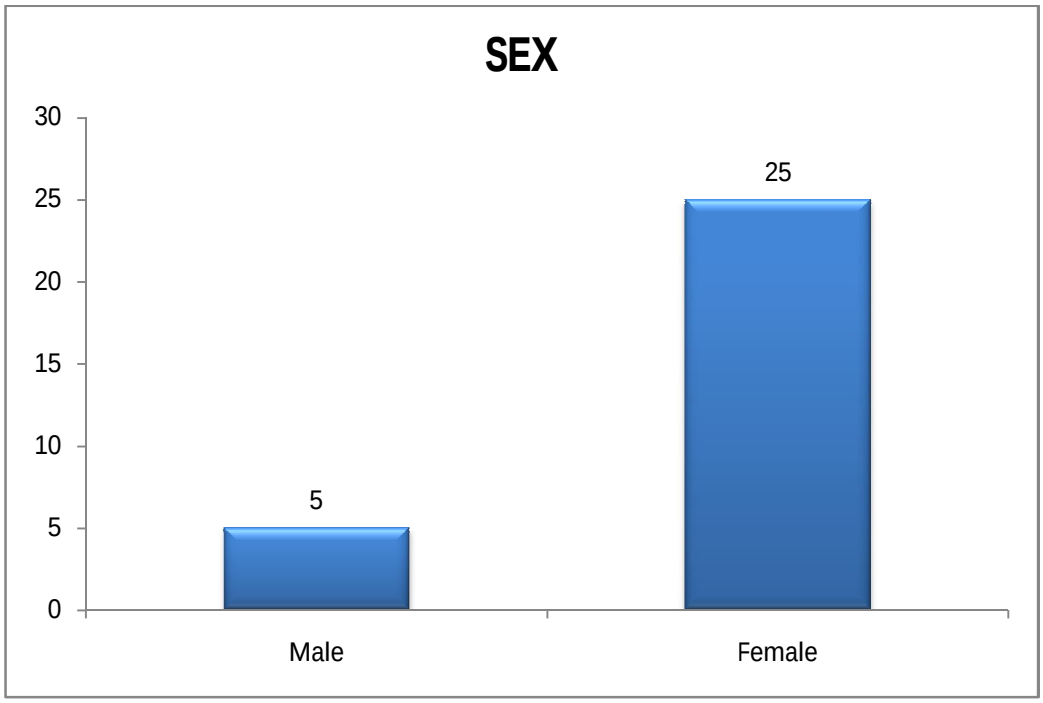


TABLE 9: SEX DISTRIBUTION OF BENIGN AND MALIGNANT LESIONS

SEX	BENIGN	PERCENT OF BENIGN LESIONS	MALIGNANT	PERDCENT OF MALIGNANT LESIONS
MALE	4	80	1	20
FEMALE	14	56	11	44

FIGURE 13:

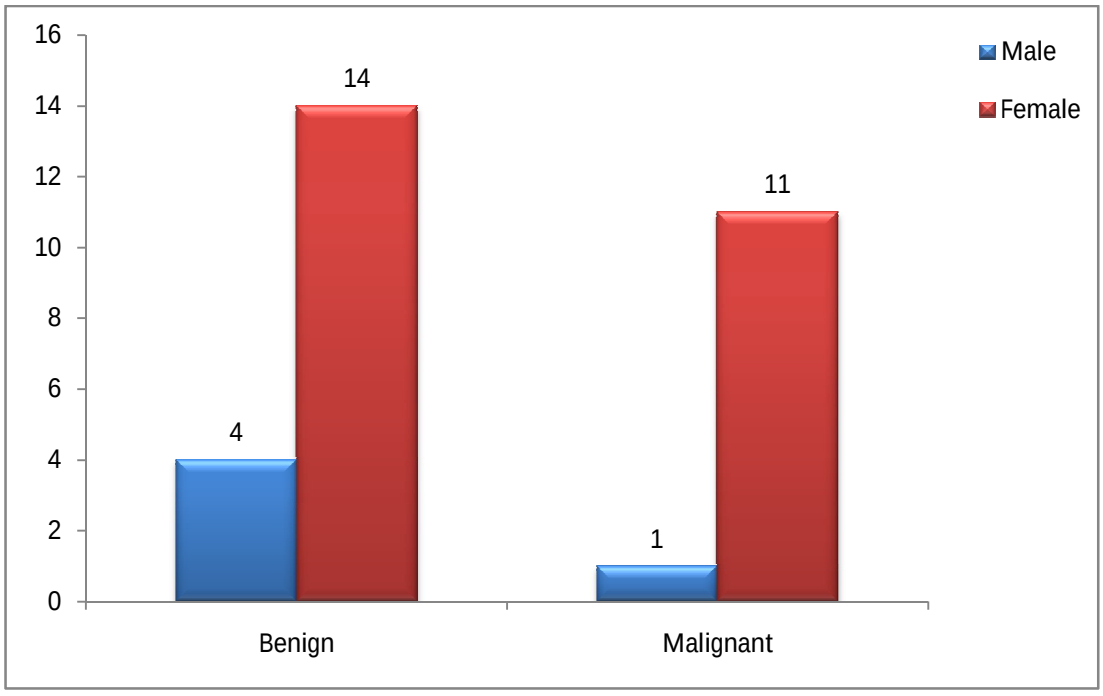


TABLE 10: LOCATION OF LESIONS

SIDE	FREQUENCY	PERCENT	BENIGN	MALIGNANT
LEFT	12	40	9	3
RIGHT	18	60	9	9
TOTAL	30	100	18	12

FIGURE 14:

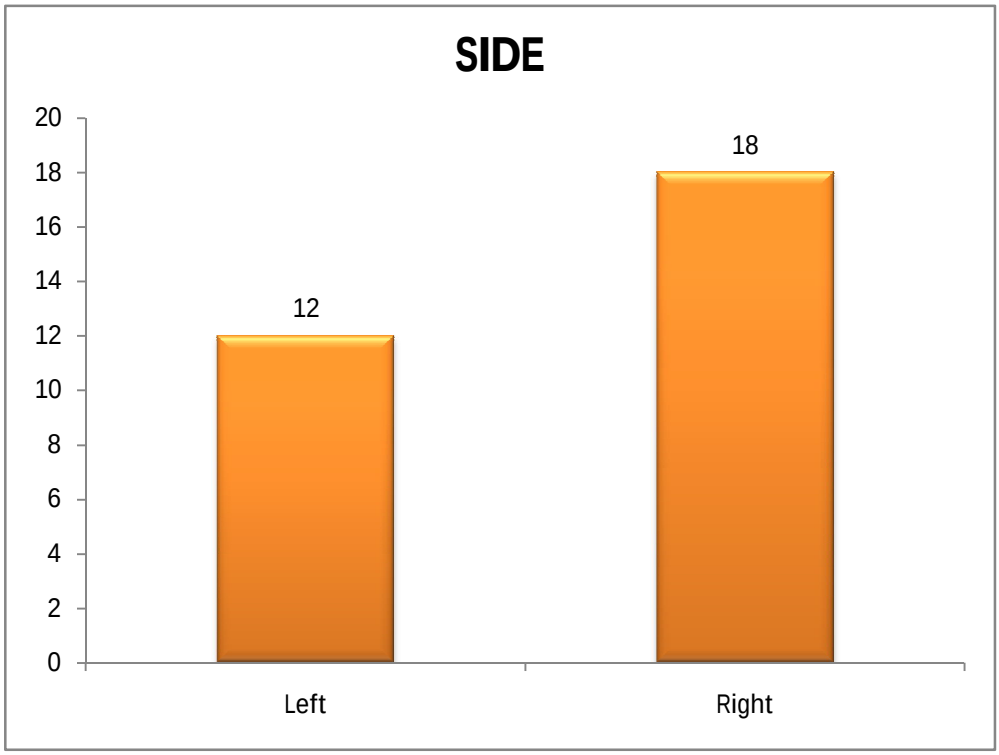
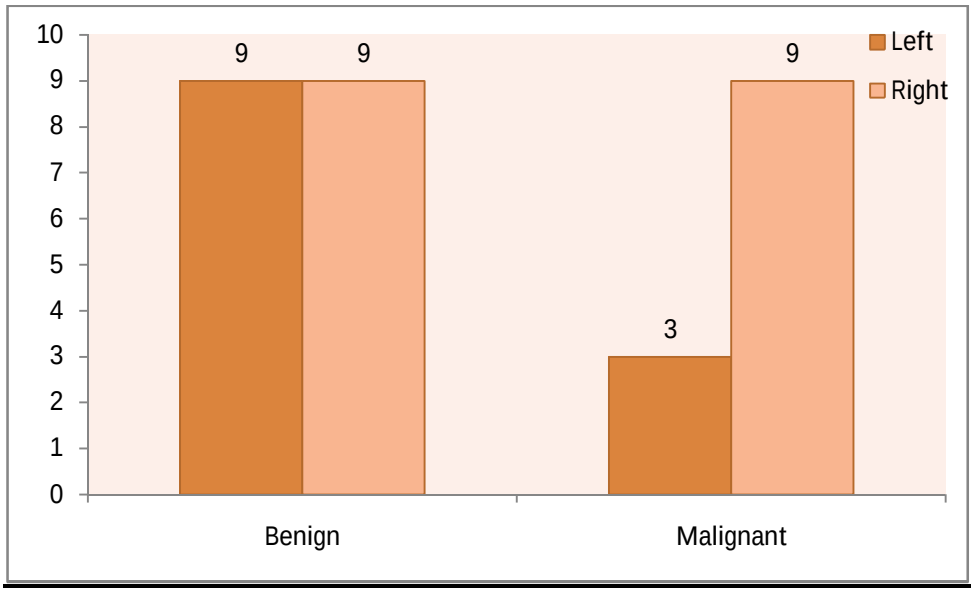


FIGURE 15: DISTRIBUTION OF LESIONS BASED ON THE LOCATION



In our study right side involvement 18 cases (60%) is higher compared to the left side 12 (40%).Among the right side lesions nine of them were benign and remaining nine were malignant. In the left side lesions nine lesions were benign and the remaining three lesions were found to be malignant.

TABLE 11: CLINICAL FEATURES

CLINICAL FINDINGS	BENIGN	MALIGNANT	FREQUENCY	PERCENT OF CLINICAL FINDINGS
HOARSENESS OF VOICE	0	3	3	10
DYSPHAGIA	1	3	4	13.3
PAIN	3	1	4	13.3
SWELLING IN THE NECK	13	1	14	46.7
WEIGHT LOSS	1	4	5	16.7
TOTAL	18	12	30	100

FIGURE 16:

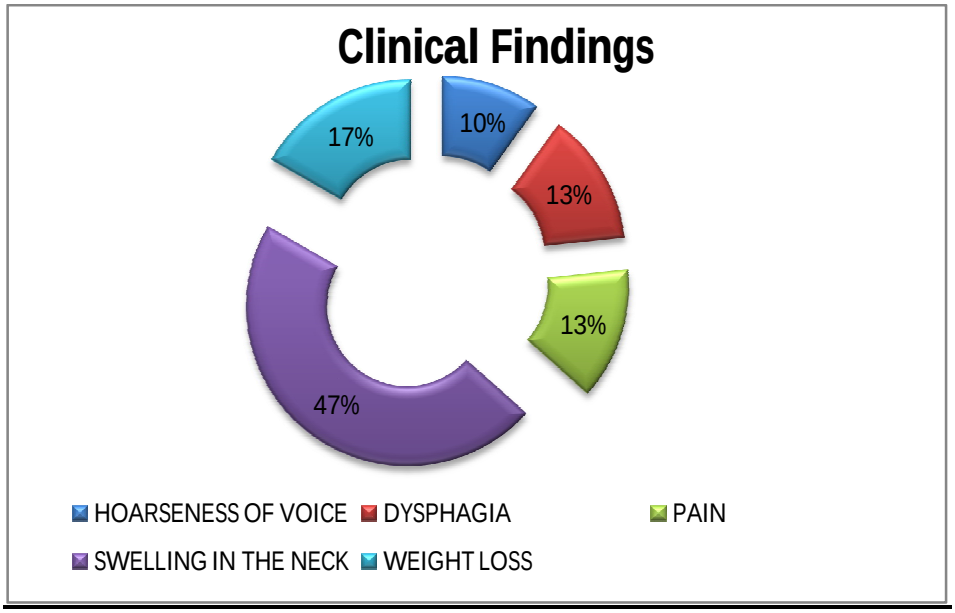
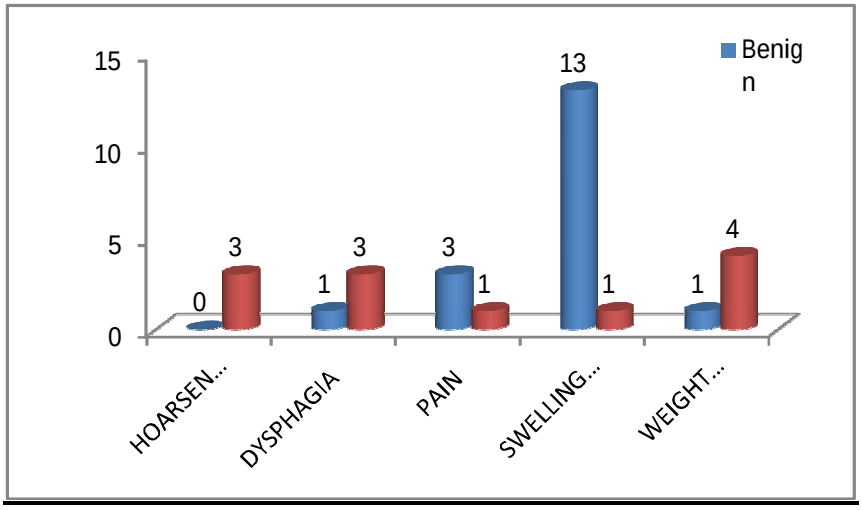


FIGURE 17: DISTRIBUTION OF LESIONS BASED ON THE CLINICAL FEATURES.



Based on the clinical findings patients most commonly presented with swelling the neck14 (47%) cases out of the 14 cases 13 cases turned out to be benign which included colloid goiter in 11 cases and adenomatoid nodule in 2 cases and only 1 case turned out to be malignant which was papillary carcinoma of thyroid. The next common complaint was weight loss 5 cases (17%) out of the 5 cases 4 cases turned out to be malignant which was papillary carcinoma and the benign case was follicular adenoma. Dysphagia 4 cases (13%) where 1 cases turned out to be adenomatoid nodule and the remaining three cases were papillary and follicular carcinoma. Pain 4 cases (13%) where 3 cases were colloid and adenomatoid nodule and 1 malignant case which was medullary carcinoma. Hoarseness of voice 3 cases(10%) where all the three cases turned out to be follicular carcinoma.

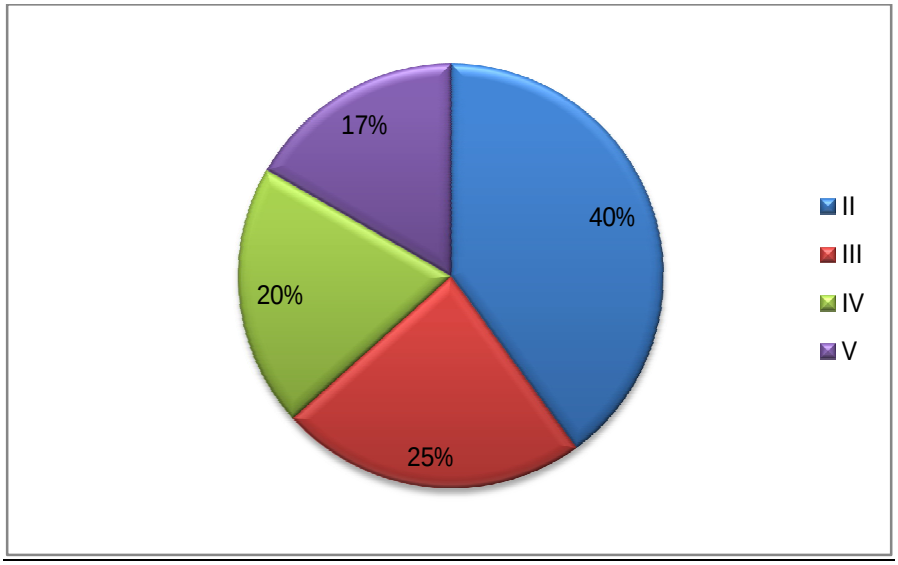
TI-RADS SCORING IN CORRELATION WITH CYTOLOGY:

On ultrasound, features such as size, location within the thyroid gland composition, echogenicity, regularity of the border or margin around the nodule, presence of a halo, vascular pattern and calcifications were taken into account and they were classified according to TI-RADS scoring system TIRADS 2 includes benign sonographic features. TIRADS 3 includes lesions which are usually benign but they may possess the risk of malignancy .TIRADS 4and 5 are malignant lesions.

TABLE 12 :TIRADS SCORING SYSTEM

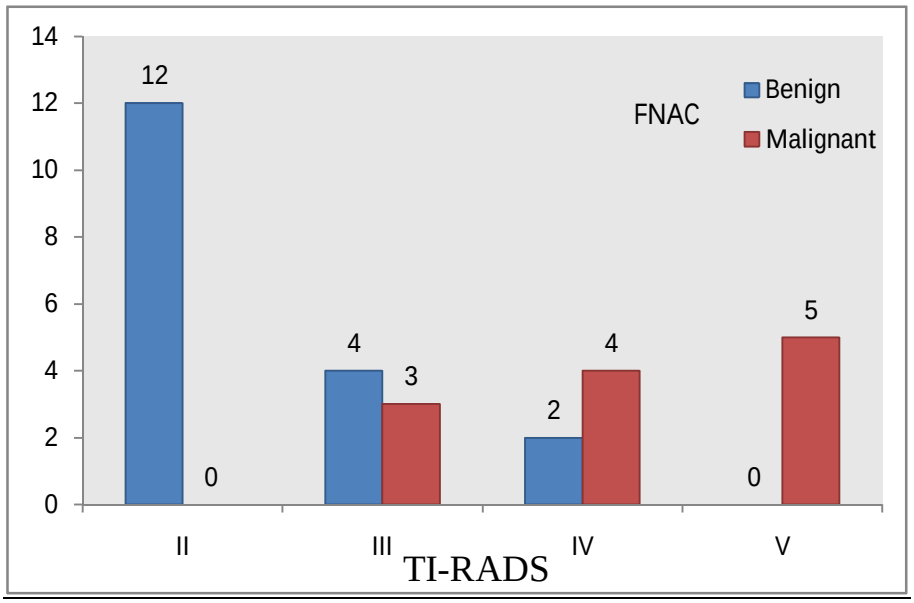
TIRADS	BENIGN	MALIGNANT	FREQUENCY	PERCENTAGE DISTRIBUTION – TI-RADS
II	12	0	12	40
III	4	3	7	23.3
IV	2	4	6	20
V	0	5	5	16.7
TOTAL	18	12	30	100

FIGURE 18:TIRADS SCORING SYSTEM



Of the 30 lesions, 12 were assigned TIRADS 2 (40%), 7 lesions (25 %) were categorized as TIRADS 3, 6 lesions (20%) were categorized as TIRADS 4, 5 lesions (17%) as TIRADS 5.

FIGURE 19: DISTRIBUTION OF FNAC PROVEN LESIONS BASED ON TIRADS SCORING SYSTEM



Of the 30 lesions, 12 were assigned TIRADS 2 (40%), and all these lesions were benign on FNAC. 7 lesions (25 %) that were categorized as TIRADS 3 out of which 4 lesions were benign which include adenomatoid lesions and colloid cyst and the remaining 3 lesions were malignant which were follicular neoplasm . 6 lesions (20%) were categorized as TIRADS 4 out of which 2 lesions were benign which include follicular adenoma and the remaining 4 lesions were malignant which include papillary neoplasm and follicular neoplasm. 5 lesions (17%) as TIRADS 5 and all these lesions turned out to be malignant on FNAC.

FIGURE 20 :DISTRIBUTION OF TIRADS SCORING SYSTEM IN CYTOLOGICAL PROVEN BENIGN LESIONS

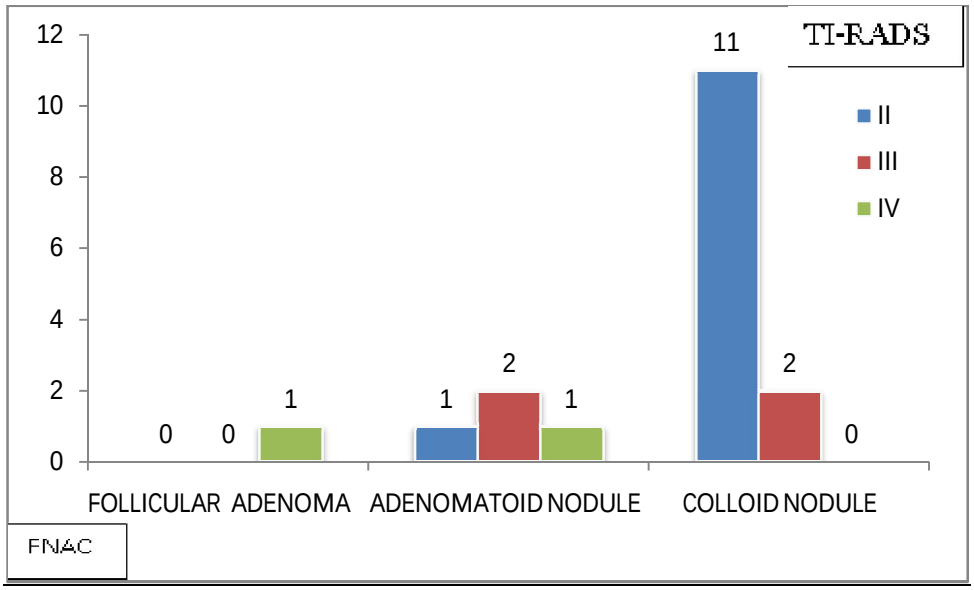


FIGURE 21 : DISTRIBUTION OF TIRADS SCORING SYSTEM IN CYTOLOGICAL PROVEN MALIGNANT LESIONS

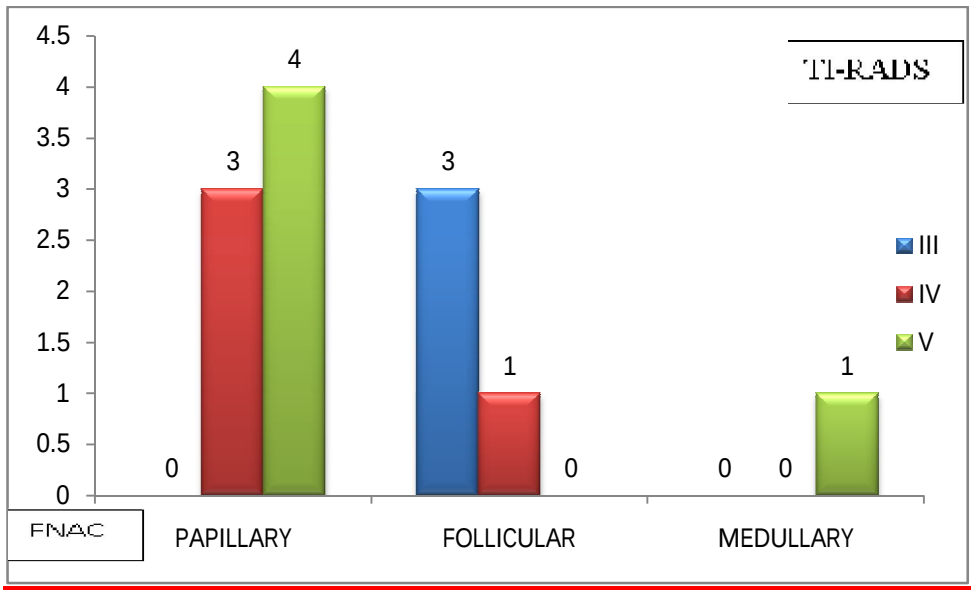


TABLE 13:

TIRADS		BENIGN	MALIGNANT	TOTAL	CHI SQ	P
2	Count	12	0	12		
	% within TIRADS	100.00%				
3	Count	4	3	7		
	% within TIRADS	57.10%	42.90%			
4	Count	2	4	6		
	% within TIRADS	33.30%	66.70%			
5	Count	0	5	5		
	% within TIRADS		100.00%			
Total	**Count**	**18**	**12**	**30**	**17.3**	**0.001**
	% within TIRADS	60.00%	40.00%			

Statistical analysis: The chi square test (value of 17.3) for association between TIRADS classification and cytology is found to be statistically significant (P value – 0.001)

ELASTOGRAPHY GRADING IN CORRELATION WITH CYTOLOGY:

Of the 30 lesions 15 lesions (50%) were categorized under grade 2, 5 lesions (17%) as grade 3 and the remaining 10(33%) as grade 4.

TABLE 14:ELASTOGRAPHY GRADING:

ELASTOGRAPHY STRAIN	NUMBER OF CASES	BENIGN LESIONS ON FNAC	MALIGNANT LESIONS ON FNAC
II	15	14	1
III	5	4	1
IV	10	0	10
TOTAL	30	18	12

FIGURE 22:

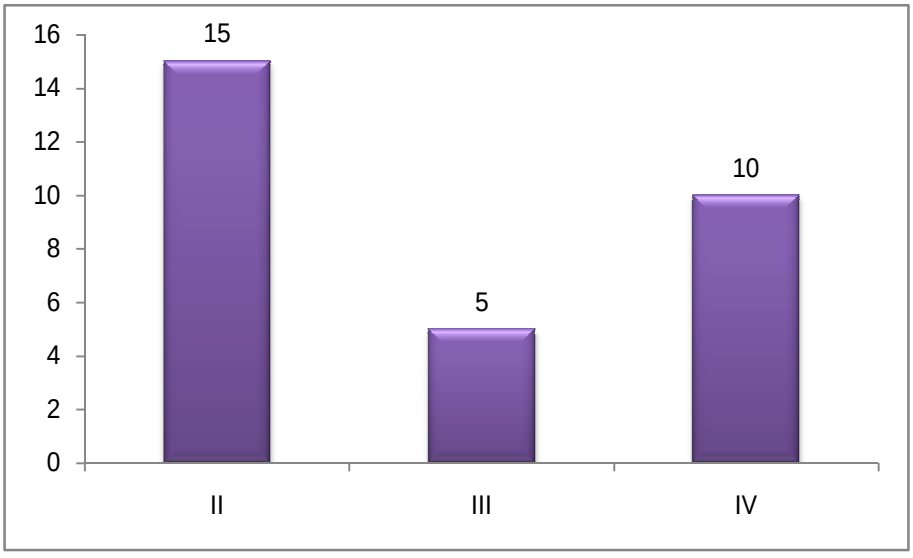
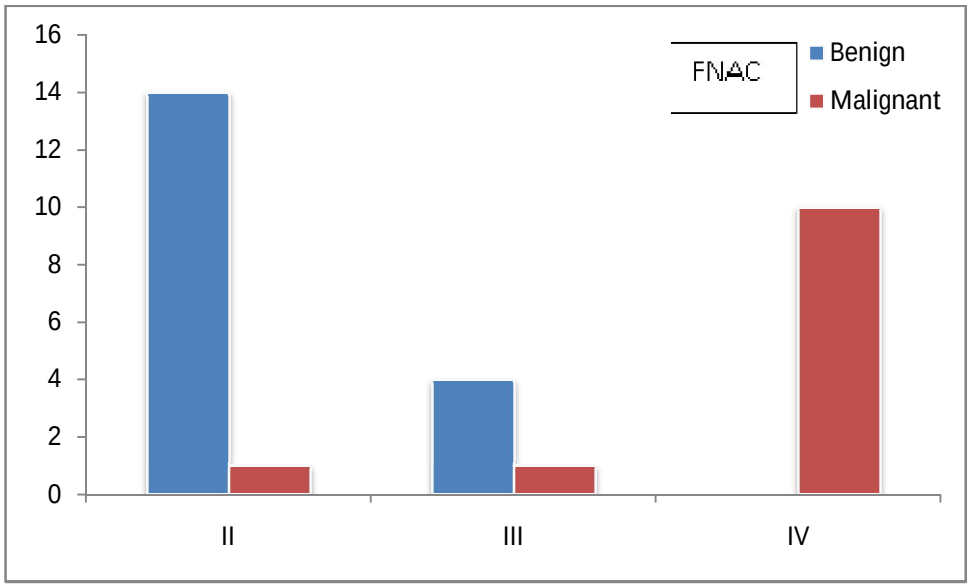


FIGURE23: DISTRIBUTION OF LESIONS BASED ON ELASTOGRAPHY GRADING



Of the 30 lesions, 15 lesions were classified under Elastography grade II. On cytology, only 1 lesion turned out to be malignant which was follicular neoplasm,.the remaining fourteen cases turned out to be benign.

Of the 5 lesions were classified under elastography grade III, On cytology only 1 lesion turned out to be malignant and the remaining 4 lesions turned out to be benign , the lesions that turned out to be benign were follicular adenoma , colloid cyst and adenomatoid nodule.

Of the 10 lesions under Elastography grade IV all the lesions turned out to be malignant on cytological correlation.

FIGURE 24: DISTRIBUTION OF ELASTOGRPAHYGRADING IN CYTOLOGICAL PROVEN BENIGN LESIONS

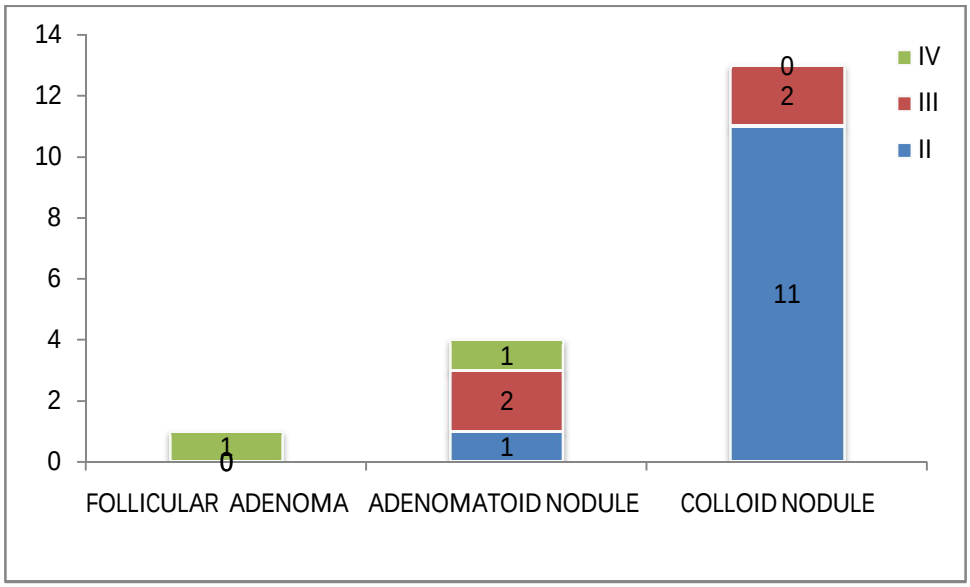


FIGURE 25: DISTRIBUTION OF ELASTOGRAPHY GRADING IN CYTOLOGICAL PROVEN MALIGNANT LESIONS

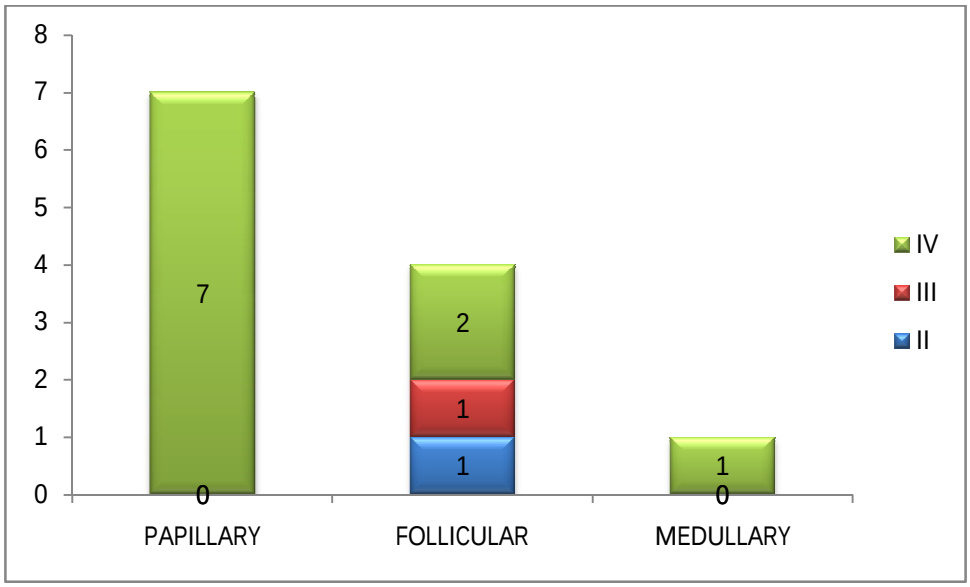


TABLE 15 :

	ELASTOGRAPHY STRAIN	**BENIGN**	**MALIGNANT**	**TOTAL**	**CHI SQ**	**P**
2	Count	14	1	15		
	% within ELASTOGRAPHY STRAIN	93.30%	6.70%	100.00%		
3	Count	4	1	5		
	% within ELASTOGRAPHY STRAIN	80.00%	20.00%	100.00%		
4	Count	0	10	10		
	% within ELASTOGRAPHY STRAIN	0.00%	100.00%	100.00%		
TOTAL	**COUNT**	**18**	**12**	**30**	**22.78**	**0.0001**
	% within ELASTOGRAPHY STRAIN	60.00%	40.00%	100.00%		

Statistical analysis:

The chi square test (value of 22.78) for association between Elastography and HPE is found to be statistically significant (P value – 0.0001

DISCUSSION

DISCUSSION

In our prospective study, 30 patients with thyroid swelling were evaluated with B mode ultrasonography and Elastography. The interpretation with each of the above mentioned modalities were compared with the cytological diagnosis.

A majority of our cases diagnosed to have solitary thyroid nodules were females (sex ration 5:1) and the age group commonly affected was the 3^{rd} to 5^{th} decade of life. The mean age of study population for malignancy was above 50 years and for benign lesions was found to be between 30-50 Years

In the study population, 18 (60%) lesions were benign and 12 (40%) lesions were malignant. Out of the 12 malignant lesions, 7 (58.3%) were papillary carcinoma, 4 (33.3 %) were follicular carcinoma and 1 (8.3%) was medullary carcinoma. Out of the 18 benign lesions, 13 (72.2%) were colloid nodule, 4(22.2%) were adenomatoid nodule and 1(5.6%) was follicular adenoma.

The most common presentation of a thyroid nodule was a painless mass in the neck. In our series, 13 cases presented with history of painless swelling in the neck of which 12 cases were diagnosed as benign and only one case turned out to be malignant. The 4 patients who

presented with a history of a painful thyroid swelling, were diagnosed to have two colloid, one adenomatoid nodule and one medullary carcinoma respectively. The next common complaint was weight loss seen in 5 cases (17%), of the 5 cases 4 cases turned out to be malignant which were papillary carcinoma and one benign case which was follicular adenoma. Complaints of dysphagia seen in 4 cases (13%) of which 1 case turned out to be adenomatoid nodule and the remaining three cases were papillary and follicular carcinoma Three patients with complaints of hoarseness of voice of which all the 3 patients were diagnosed to be follicular carcinoma.

Following clinical evaluation of 30 patients in whom diagnosed to have solitary thyroid nodules were referred for ultrasound examination the nodule is categorized with the following features such as size, location within the thyroid gland, composition, Echogenicity, regularity of the border or margin around the nodule, presence of a halo, vascular pattern and calcifications and they were graded according to TI-RADS scoring system .It was found that in our case study 75% of the malignant lesions had irregular or poorly defined borders with lobulated margins. And 68 % of the malignant cases had microcalcification. Nodules with cystic component 66% of the cases were mostly benign and none of the nodules with cystic component were malignant. Most of the benign

nodules 77% of them were hyperechoic and none of the hyperechoic nodule was malignant.

Out of the 30 lesions 12 lesions (40%) were categorized as TIRADS 2 of which all the lesions turned out to be benign on FNAC so the correlation is 100% for benign lesions based on TIRADS grading,

Out of the 7 lesions (25.3 %) were TIRADS 3 of which 4 lesions(57%) were benign and the remaining 3 lesions (43%) were malignant .The four benign lesions were adenomatoid lesions and colloid cyst . The three malignant lesions were follicular neoplasm .These lesions appeared hyperechoic when compared with the adjacent strap muscles with small cystic components within. They also showed peripheral vascularity so they were graded under TIRADS 3 but on cytology they turned out to be follicular neoplasm.

Out of the 6 lesions (20%) were TIRADS 4 of which 2 lesions (33%) were benign and the remaining 4 lesions (67%) were malignant. The two benign lesions were follicular adenoma which appeared hypoechoic with cystic component compared to the surrounding strap muscles and internal vascularity was also noted within one lesion, since these lesions had more than one feature favouring malignancy they were categorized as TIRADS 4 but on cytology these lesions turned out to be benign and

the remaining 4 malignant lesions were papillary and follicular neoplasm ,these lesions had more features favouring malignancy which included hypoechogenicity, irregular margins intranodular vascularity and papillary carcinoma also showed microcalcification.

Out of the 5 lesions (16.7%) were categorized as TIRADS 5 and all these lesions turned out to be malignant on FNAC showing 100% correlation.

Thus based on the TIRADS scoring system the correlation with FNAC was 100 % for TIRADS 2 and TIRADS 5 lesions where as TIRADS 3 lesions were 57 % benign and 43 % malignant and in TIRADS 4 it was 33% benign and 68 % malignant condition.

According to the study done by **B. Raghavan et al** [32] the correlation of the benign lesions were 99.2% in TIRADS 2 and 100% in TIRADS 3 category, the correlation of the lesion being malignant was 100% in TIRADS 4 category and 91% in TIRADS 5. But in our study we found that the correlation rate was 100% in TIRADS 2 and TIRADS 5 category which was significantly high.

Based on the elastography finding out of the 30 lesions 15 lesions (50%) were categorized under GRADE 2, 5 lesions (17%) as GRADE 3 and the remaining 10(33%) as GRADE 4.

Of the 30 lesions,15 lesions were classified under Elastography GRADE II of which 1 lesion turned out to be malignant on cytology which was follicular neoplasm. This lesion was categorized under GRADE 3 on TIRADS scoring system .The remaining fourteen cases turned out to be benign. In the case of follicular neoplasm the peripheral zone of the tumor tend to be hard and displayed in blue and the central zone appears to be soft which appears as light green so it appeared on elastography as GRADE 2 but on histopathology it turned out to be malignant follicular neoplasm . Correlation was found to be 93% for GRADE II elastography lesions. 5 lesions that were classified under elastography GRADE III, which On histopathological evaluation only 1 lesion turned out to be malignant(20%) and the remaining 4 lesions(80%) turned out to be benign , the lesions that turned out to be benign were follicular adenoma , colloid cyst and adenomatoid nodule. Of the 10 lesions under Elastography GRADE IV all these lesions turned out to be malignant with 100% histopathological correlation.

On Elastography, 15 lesions were suspected to be malignant (GRADE III and IV), of which 11 lesions turned out to be malignant and the remaining 4 lesions turned out to be benign. Out of the 15 benign lesion(GRADE II) 14 lesions turned out to be benign and only 1 lesion turned out to be malignant .

According to the study conducted by **Mona A. EL-Hariri et al**[31] they found that Fifty-four of the 84 nodules had scores of 1 and 2, and 50 of these nodules were diagnosed histopathologically as benign. Thirty of the 84 nodules had a score of 3 and 4, and 21 of these nodules were diagnosed histopathologically as malignant. The scores of 1 and 2 with Itoh criteria were significantly seen in benign nodules, whereas, scores of 3 and 4 were significantly seen in malignant nodules ($p < 0.05$) with sensitivity 84%, specificity 84.7%, PPV 70%, NPV 92.6% and accuracy 84.5%.

Using **Rago's criteria** [3] the reasearchers calculated 97% as sensitivity as 100 %specificity for predicting malignancy in a study that was done with single thyroid nodule in 92 consecutive patients .Using **Asteria's criteria**, the researchers calculated 94 % as sensitivity and 81 % as specificity in 86 nodules. These two investigators found the diagnostic performance of ultrasound feature on grey scale individually. The main drawback was they did not evaluate combinations of ultrasound features with elastography. In practice elastography is not done as a independent test and it is usually done as an extension of conventional Ultrasound.

Thus in our study Elastography has a sensitivity of 77.7% and specificity of 91.7%, positive predictive value of 93.3% and negative

predictive value of 73.3%. when compared to the study conducted by the Asteria et al [3] it is found that our study has increased specificity even though sensitivity is less.

SUMMARY

SUMMARY

This was a prospective study of thyroid nodules which was done in 30 patients using B-mode ultrasonography and elastography and the interpretation from the individual modalities were compared with Cytology. Nodules were found predominantly in females (Ratio 5:1).. Benign lesions accounted for 60% of the patients and malignant lesions for 40%.

The benign lesions in descending order of occurrence in our study were Colloid nodules (72%) Adenomatoid nodule (22%) and follicular adenoma(6%).

Malignant lesions in descending order of occurrence were Papillary carcinoma (58%). Follicular carcinoma (33%), and medullary carcinoma(8%) The most common malignant lesion was papillary carcinoma (58%). The diagnostic accuracy on US in prediction of papillary carcinoma was 100 %

After B-mode Ultrasound examination, the lesions were categorized using the TIRADS scoring and correlated with cytology. The diagnostic accuracy of TIRADS scoring system in correlation with FNAC was 100 % for TIRADS 2 and TIRADS 5 lesions and the overall

diagnostic accuracy of TIRADS in the evaluation of solitary nodule was found to be 81%.

The correlation for GRADE 2 elastographic lesions was 93% for benign lesions and for GRADE 4 elastographic lesions was 100% in the case of malignant lesions. Elastography has a sensitivity of 77.7%, specificity of 91.7%, positive predictive value of 93.3% and negative predictive value of 73.3%.

CONCLUSION

CONCLUSION

- High frequency ultrasound is an ideal imaging technique for characterizing solitary thyroid nodules due to its superior anatomical resolution. Above all, it is safe because of its non invasive nature and lack of ionizing radiation.
- B-mode Ultrasound findings along with elastography correlation yields a better diagnosis.
- Ultrasound elastography seems to have great potential as a new tool for differentiating solid thyroid nodules and recommending site for FNAC

RECOMMENDATIONS AND LIMITATION

RECOMMENDATIONS

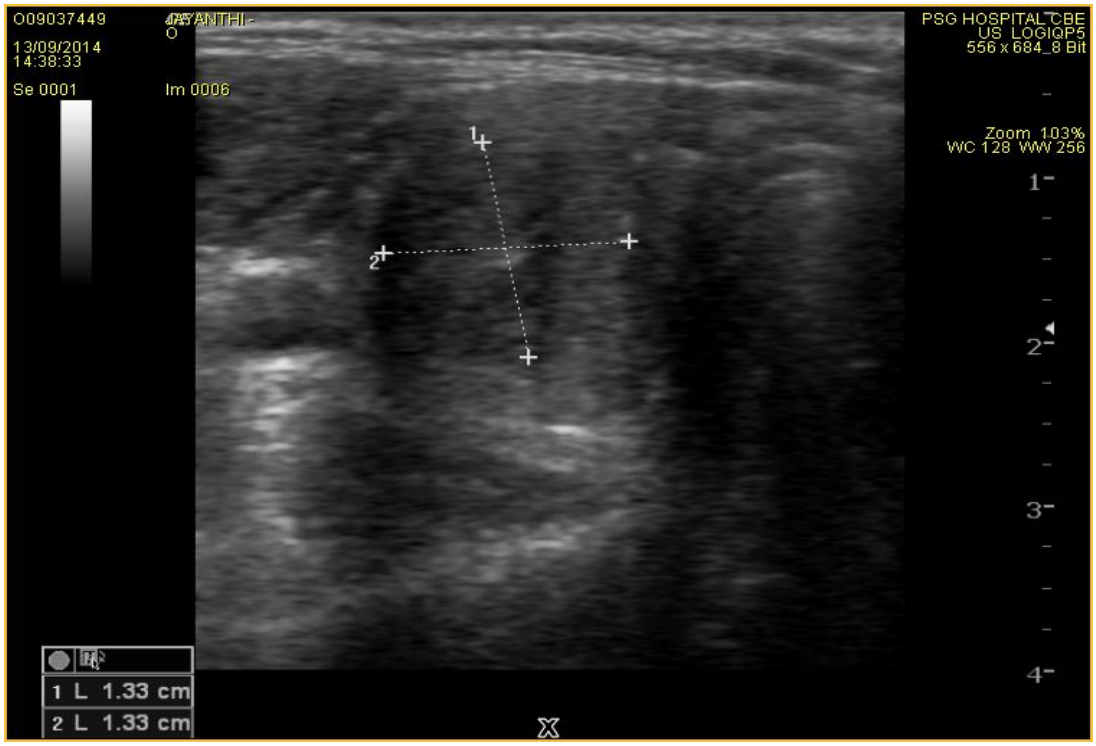
- Ultrasound serves as a valuable tool to guide the FNAC needle especially in the case of thyroid nodule (< 1.5 cm)
- We would propose to use Elastography as a complimentary tool along with B-mode.
- Elastographic characterization of a lesion should be made after analyzing the B-mode characteristics of the lesion.
- Experience is needed to evaluate more cases of follicular lesions and the role of elastography appearance in these lesions.

LIMITATIONS OF ULTRASOUND ELASTOGRAPHY

- Large prospective studies are needed to confirm these results and establish the accuracy of the new technique.
- Varying compression techniques among performers may influence the strain images, resulting in inter observer variability in Elastography interpretation of the lesion.
- Elastographic results can be affected by the characteristics of the nodule which include calcifications, cystic components, and carotid artery pulsation.

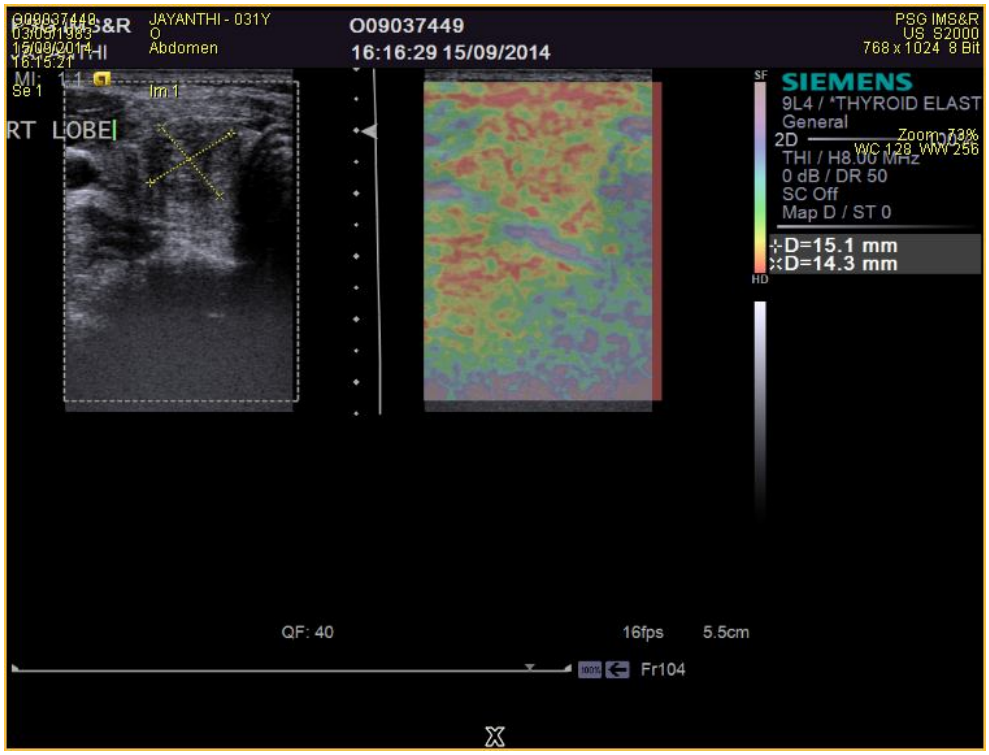
IMAGES

FIGURE 26 (A) PAPILLARY CARCINOMA:



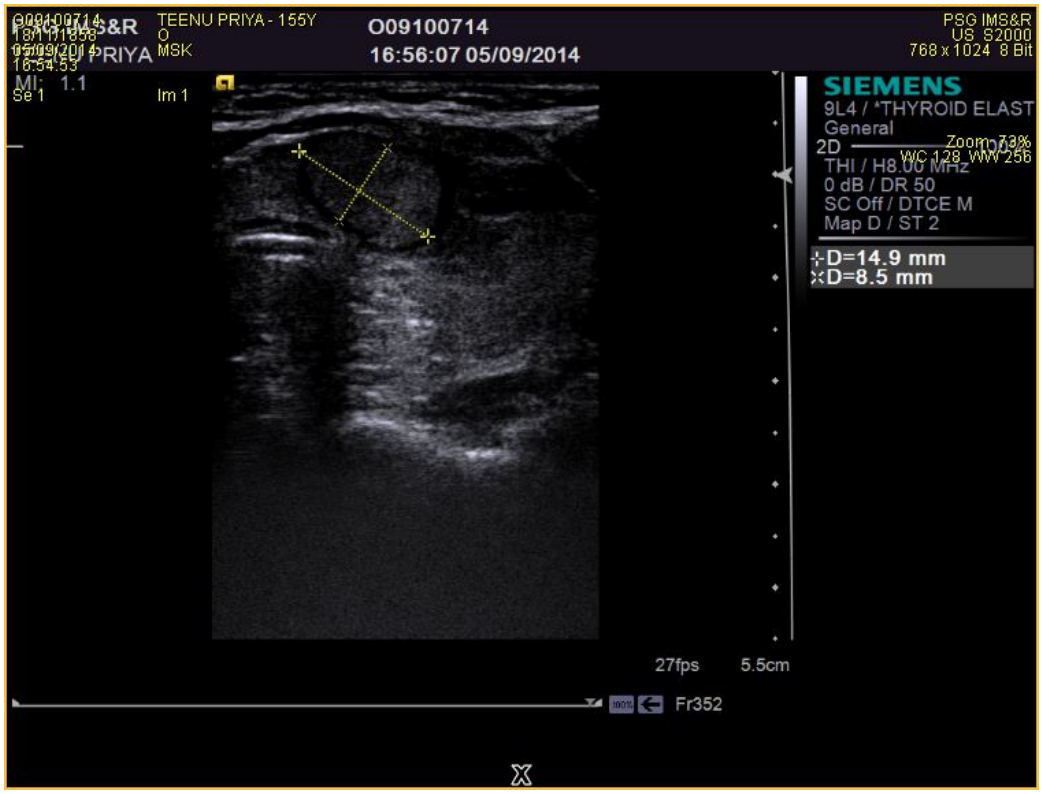
On ultrasound there is a hetrogenous nodule in the right lobe of thyroid with few specks of calcification and internal vascularity which was graded under TIRADS 4

FIGURE 26(B):



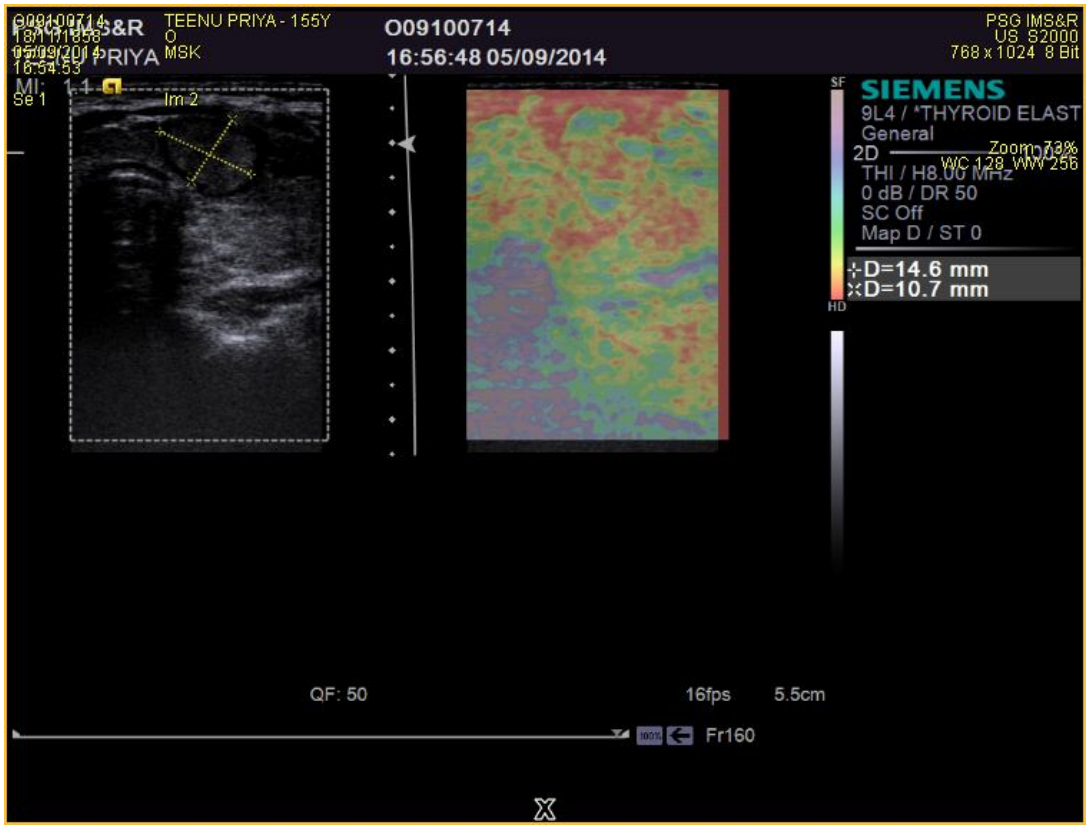
On elastography this lesion appears hard which is categorized as GRADE 4

FIGURE 27(A)FOLLICULAR CARCINOMA;



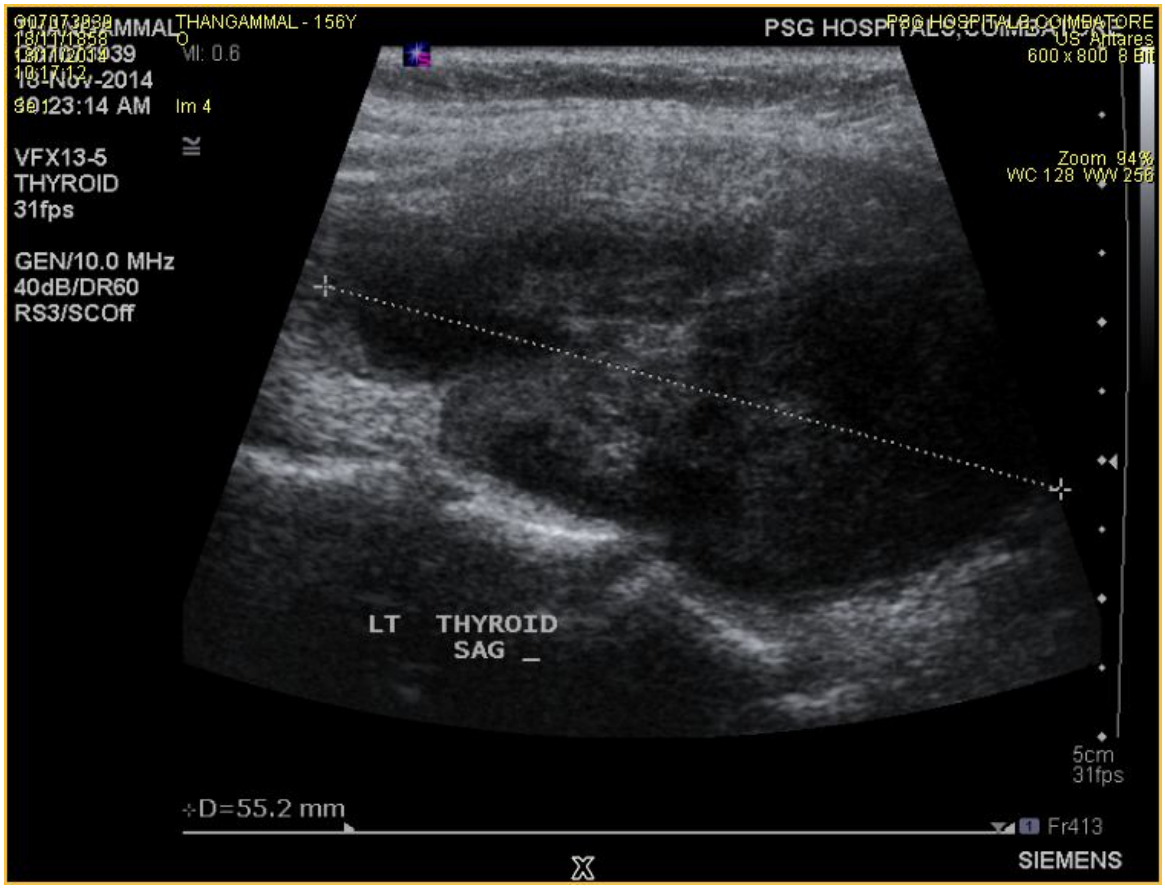
On ultrasound there is a well defined isoechoic nodule with hypoechoic rim with peripheral vascularity and no evidence of calcification which was graded as TIRADS 3

FIGURE 27(B):



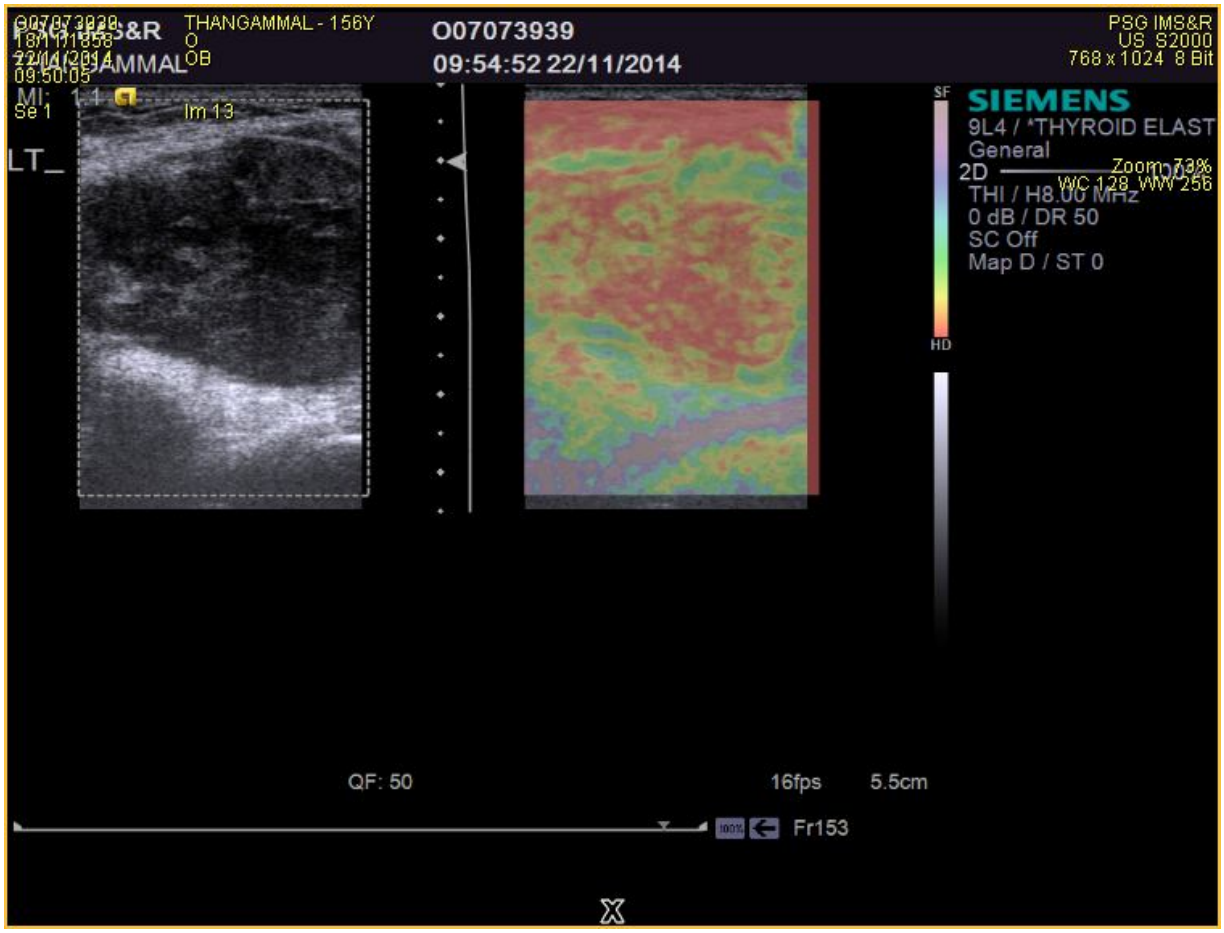
On elastography these lesions appears hard which was graded as GRADE 4 suggesting the possibility of malignancy

FIGURE 28(A) MEDULLARY CARCINOMA;



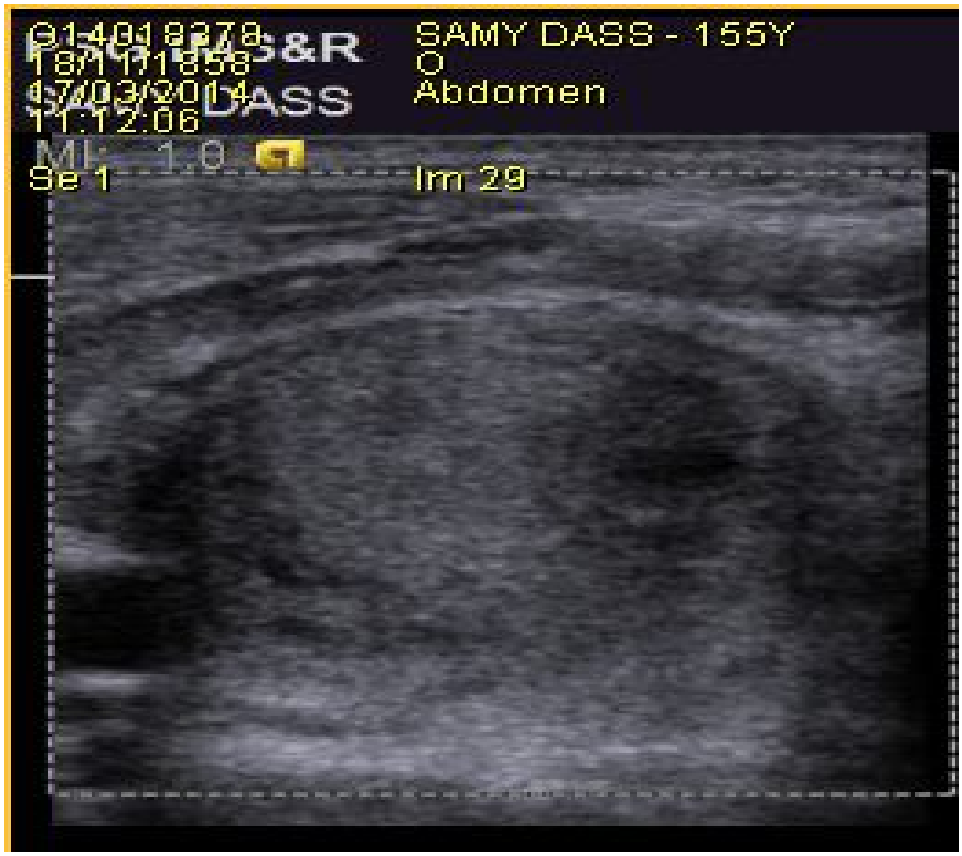
On ultrasound there is a lobulated heterogeneously hypoechoic mass with echogenic septations and internal vascularity margins appear irregular along with lymph node involvement. This was graded as TIRADS 5.

FIGURE 28(B)



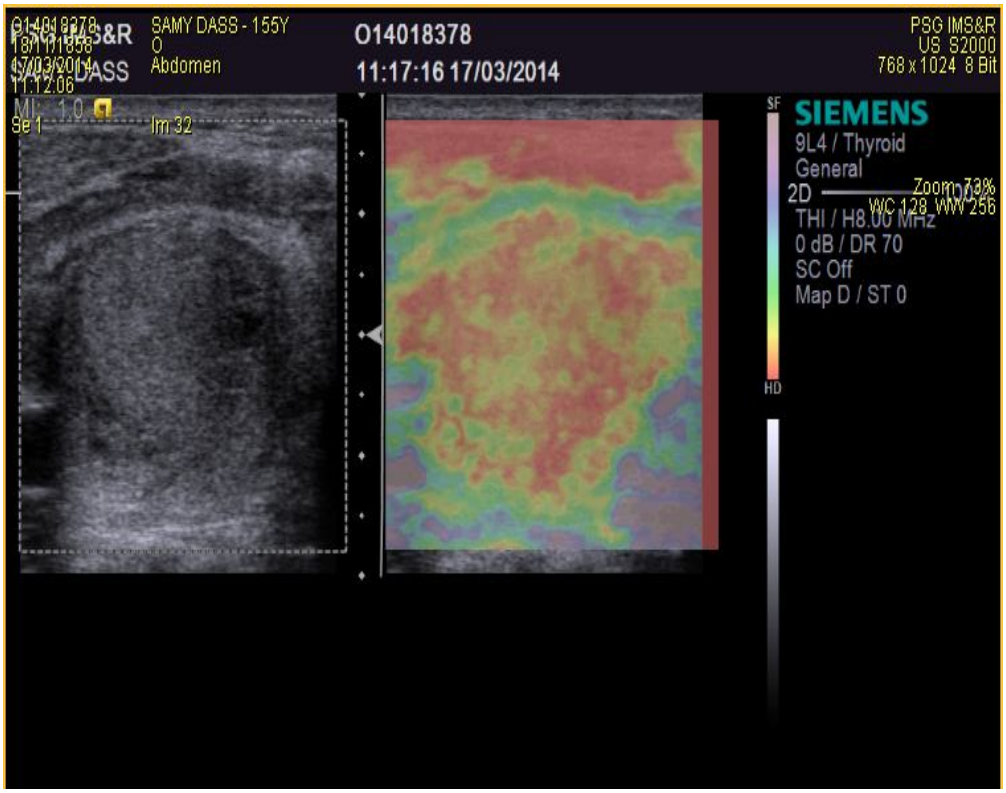
On elastography this lesion appears hard which was graded under GRADE 4.

FIGURE 29(A) FOLLICULAR ADENOMA



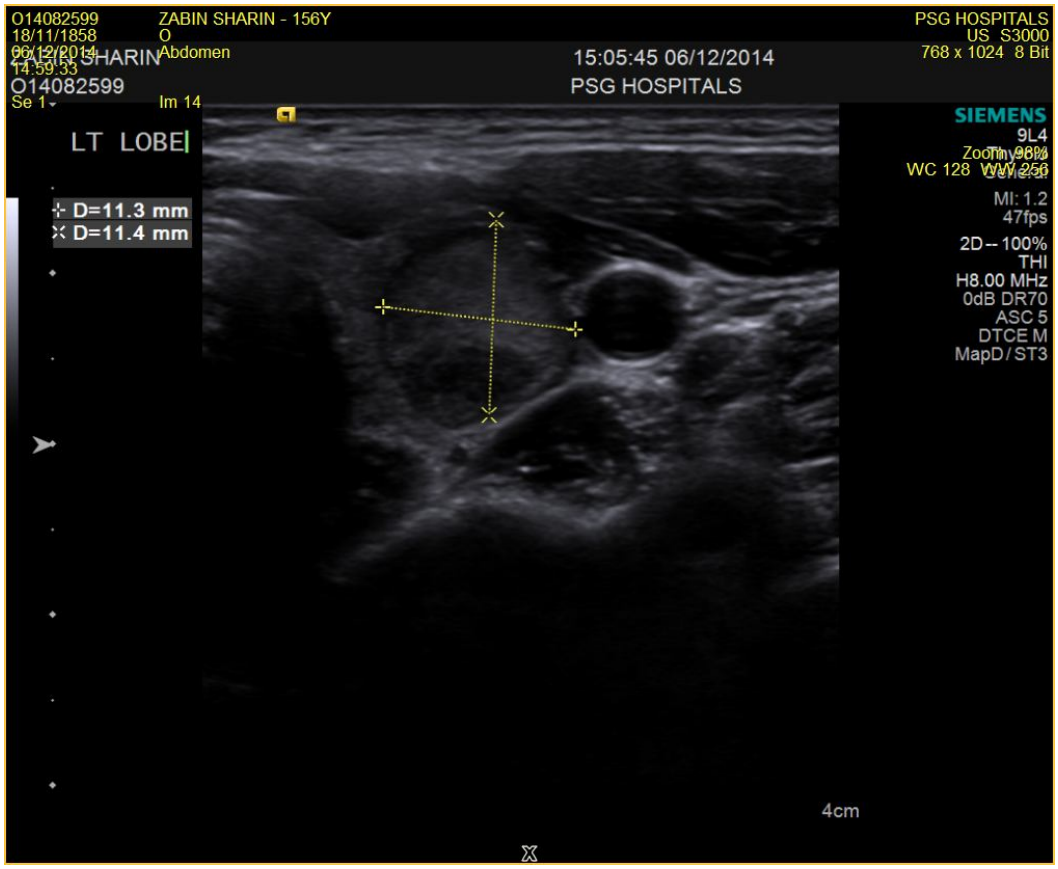
On ultrasound there is a well defined solid lesion with few cytic component within the lesion . On colour doppler ther is internal vascularity within the lesion which was graded as TIRADS4.

FIGURE 29(B):



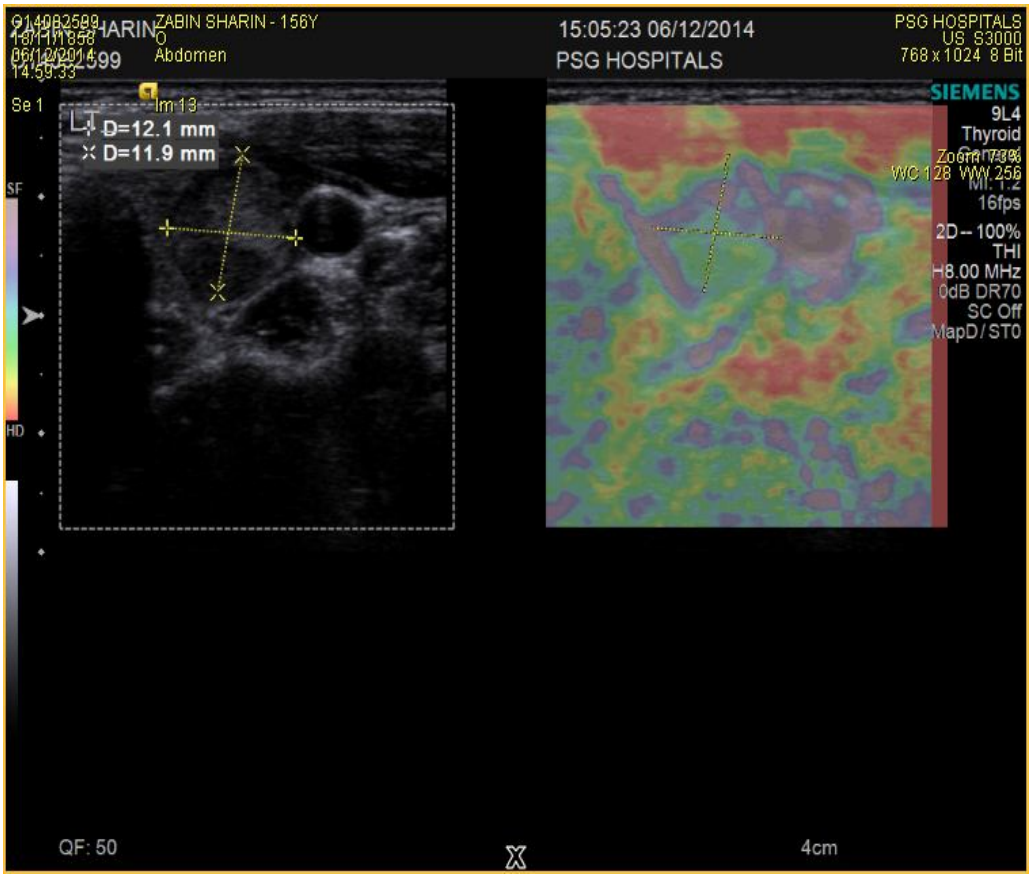
On elastography this lesion appears hard which represents both solid and cystic component –GRADE 3.

FIGURE 30(A) NODULAR COLLOID GOITRE;



On ultrasound there is a well defined nodule with a small cystic component noted within the lesion which was graded under TIRADS 2

FIGURE 30 (B):



On elastography this lesions appears soft which was categorized under GRADE 2

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Nesreen Mohey et al, Role of combined grey scale US and US tissue elastography in differentiating solid thyroid nodules, The Egyptian Journal of Radiology and Nuclear Medicine (2013) 44, 505–512
2. Horvath E, Majlis S, Rossi R et-al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. J. Clin. Endocrinol. Metab. 2009;94 (5): 1748-51. doi:10.1210/jc.2008-1724
3. Jin Young Kwak et al Ultrasound elastography for thyroid nodules: recent advances, The Egyptian Journal of Radiology and Nuclear Medicine (2013) 44, 505–512
4. Alptekin Gürsoy et al Ultrasonographic Approach to Thyroid Nodules: State of Art
5. Jenny K. Hoang et al : US Features of Thyroid Malignancy: Pearls and Pitfalls 848 May-June 2007 RG f Volume 27 ● Number 3.
6. Campbell et al : Management of the thyroid nodule Head & neck 1989;11 : 414 – 425.
7. Rumack Diagnostic Ultrasound 2nd Edition

8. Yamakawa et al : Diagnostic ultrasound applications in the disease of thyroid : Proceedings of the I International conference, University of pottsburg. 1966.
9. Fujimoto Y et al : Ultrasound scanning of the thyroid gland as a new diagnostic approach Ultrasonics 1977 ; 5.
10. Blum M et al : clinical application of thyroid echography N Engl J med ; 1972 : 287 : 1164.
11. Sackler JP et al : A spectrum of the diseases of the thyroid gland as imaged by grey scale water path sonography. Radiology 1977;125 : 467
12. Siomeone et al ; High resolution real time sonography of the thyroid. Radiology 1982 ; 145 : 431.
13. Zachrisson, B.F et al : Thyroid angiography Acta radiol (suppl) 1976;350;1 –112.
14. KatzJF et al : Thyroid nodules – Sonographic pathologic correlation. Radiology ; 151 : 741
15. Solbiati L et al : The thyroid gland with low uptake Radiology 1985 ; 155 : 187 – 191.
16. Walker J et al : A prospective study of thyroid ultrasound scan in the clinically solitary thyroid nodules. Br. J. Radiol 1985 ; 58 : 617 –619.

17. M.R. Cox et al : Solitary thyroid nodule : a prospective evaluation of nuclear scanning & ultrasonography. Br. J.surg 1991; 78:90–93.
18. Ellen marqusee et al : Usefulness of ultrasonography in the management of Nodular thyroid disease Ann intern med 2000 ; 133 : 696 – 700.
19. Heged C et al : Thyroid ultrasound: Endocrinol metab clin North AM 2001 ; 30 : 339 – 360.
20. Papini E et al : Risk of malignancy in non palpable thyroid nodules : Predictive value of ultrasound and color – Doppler features. J clin endocrinol Metab 2002 ; 87 : 1941-46.
21. Giammanco M et al : Role of color flow Doppler sonography in pre operative diagnosis of thyroid pathology. Minerva endocrinol 2002 ; 27 ; 1-10.
22. Chilcote WS et al; Grey scale ultrasonography of the thyroid Radiology 1976;120:381.
23. Hayashi et al : Real time ultrasonography of thyroid nodules Acta Radiol 1986;87
24. Gooding GAW et al : Malignant carotid artery invasion : sonographic detection. Radiology 1989;171-435

25. Hajeck Pc et al : Lymphnodes of the neck. Evaluation with ultrasound. Radiology 1986; 158: 739
26. Okamoto T et al : Test performances of three diagnostic procedures in evaluating thyroid nodules: Physical examination, Ultrasound & FNAC. Endocr J 1994;41(3):243-247
27. Jones AJ et al: Comparison of FNAC, Radioisotope & ultrasound scanning in the management at thyroid nodules. Post graduate Medical Journal 1990;66:914-917.
28. 28. Lin JD et al: Thyroid ultrasound with FNAC for the diagnosis of thyroid cancer. J Clin ultrasound 997;25:111-118.
29. J. Fernández Sánchez et al :TI-RADS classification of thyroid nodules based on a score modified according to ultrasound criteria for malignancy Radiology and Nuclear Medicine, Robert-Bosch
30. Belfiore A et al: Cancer risk in patients with cold thyroid nodules : Relevance of iodine intake, age, sex & multinodularity Am J Med 1992;93: 363-369
31. Mona A. EL-Hariri et al: The clinical value of ultrasound elastograph in predicting malignant thyroid nodules The Egyptian Journal of Radiology and Nuclear Medicine (2014) 45, 353–359.

32. Manju Bala Popli et al: Utility of gray-scale ultrasound to differentiate benign from malignant thyroid nodules. Indian Journal of Radiology and Imaging / February 2012 / Vol 22 / Issue 1

ANNEXURES

LIST OF TABLES:

LIST OF FIGURES:

MASTERCHART

SNO	NAME	IP/OP NO	AGE	SEX	CLINICAL FINDINGS	SIDE	ECHOGENICITY AND COMPOSITION	VASCULARITY	TIRADS	ELASTOGRAPHY STRAIN	FNAC
1	RAMASUBBIAH	O09011718	56	M	HOARSENESS OF VOICE	RIGHT	HETEROGENOUS NODULE	PERIPHERAL	3	3	FOLLICULAR NEOPLASM
2	TEENUPRIYA	O09100714	15	F	DYSPHAGIA	RIGHT	ISOECHOIC NODULE WITH HYPOECHOIC RIM	INTERNAL	3	4	FOLLICULAR NEOPLASM
3	JAYANTHI	O09037449	31	F	DYSPHAGIA	RIGHT	HETROGENOUS NODULE	INTERNAL	4	4	PAPILLARY NEOPLASM
4	SARASWATHY	O14004365	51	F	WEIGHT LOSS	RIGHT	HETEROGENOUS NODULE	INTERNAL	5	4	PAPILLARY CARCINOMA.
5	RANGAL	O14064170	55	F	SWELLING IN THE NECK	RIGHT	HETEROGENOUS NODULE WITH CYSTIC CHANGES.	INTERNAL	4	4	PAPILLARY NEOPLASM
6	SAMY DASS	O14018378	35	M	WEIGHT LOSS	RIGHT	COMPLEX SOLID CYSTIC NODULE	PERIPHERAL	4	3	FOLLICULAR ADENOMA WITH EXTENSIVE HURTHLE CELL CHANGE, CYSTIC AND DEGENERATIVE CHANGES
7	SHYAMALA	O08014919	36	F	HOARSENESS OF VOICE	RIGHT	ECHOGENIC NODULE AND CENTRAL CYSTIC DEGENERATION.	NO	3	**2**	FOLLICULAR NEOPLASM 2.ADENOMATOUS CHANGE IN A NODULAR COLLOID GOITRE.
8	PAPPAMAL	**O14083287**	**85**	**F**	**WEIGHT LOSS**	**RIGHT**	HETEROGENOUS HYPOECHOIC NODULE WITH INTERNAL CYSTIC CHANGES	INTERNAL	4	**4**	PAPILLARY CARCINOMA
9	THANGAMMAL	O07073939	70	F	PAIN	LEFT	LOBULATED HETEROGENOUSLY HYPOECHOIC MASS WITH ECHOGENIC SEPTATIONS	INTERNAL	5	4	MEDULLARY CARCINOMA.

10	GIRIJA	O14081358	36	F	DYSPHAGIA	RIGHT	WELL DEFINED HETEROGENOUS HYPOECHOIC NODULE WITH INTERNAL CYSTIC CHANGES	INTERNAL	5	4	PAPILLARY CARCINOMA.
11	PRANATHI	O14000932	65	F	SWELLING IN THE NECK	LEFT	HOMOGENOUS ISOECHOIC NODULE .FEW SMALL HYPOECHOIC AREAS/COLLECTION IN THE NODULE	NIL	2	2	COLLOID GOITRE
12	UMAKARYAM	O06041604	48	M	SWELLING IN THE NECK	RIGHT	WELL DEFINED CYSTIC AREA WITH MULTIPLE SEPTATIONS AND LOCULATIONS.	PERIPHERAL	3	2	ADENOMATOUS NODULE IN COLLOID GOITRE
13	RAJ ABRAHAM	O14062792	46	M	SWELLING I N THE NECK	RIGHT	HETEROGENOUS NODULE WITH WELL DEFINED CYSTIC AREAS AND SEPATATIONS	NIL	4	3	ADENOMATOUS CHANGE IN A NODULAR COLLOID GOITRE.
14	ZABIN	O14082599	19	F	PAIN	LEFT	HETEROGENOUS NODULE WITH SOLID AREAS	NIL	2	2	LEFT LOBE OF THYROID - NODULAR COLLOID GOITRE.
15	SHANTHI	O11026781	33	F	SWELLING IN THE NECK	RIGHT	HYPER TO ISOECHOIC LESIONS WITH ANECHOIC AREAS	NIL	2	2	NODULAR COLLOID GOITER WITH CYSTIC CHANGES..
16	DHANALAKSHMI	O14060238	38	F	SWELLING IN THE NECK	LEFT	HETEROGENOUS NODULE WITH SOLID AND CYSTIC AREAS	NIL	2	2	CYSTIC LESION THYROID.

17	SANDHYA	O14004931	26	F	SWELLING IN THE NECK	LEFT	WELL DEFINED HYPERECHOIC LESION WITH CYSTIC COLLOID DEGENERATION .	PERIPHERAL	2	3	NODULAR COLLOID GOITER WITH HYPERPLASIA
18	JOTHIMANI	O14068280	52	F	PAIN	RIGHT	WELL DEFINED THICK WALLED CYSTIC LESION WITH INTERNAL SOLID COMPONENT BENIGN COLLOID NODULE WITH CYSTIC DEGENERATION	NIL	2	2	NODULAR COLLOID GOITER.
19	JAYANTHI	O03017789	47	F	SWLLING IN THE NECK	LEFT	HETEROGENOUS NODULE WITH FEW CYSTIC CHANGES	NIL	3	2	LEFT LOBE OF THYROID - FEATURES OF COLLOID GOITRE WITH DEGENERATIVE CHANGES.
20	RAJAMANI	O13090840	43	F	SWELLING IN THE NECK	LEFT	HYPERECHOIC NODULAR LESION IN RIGHT LOBE OF THYROID WITH CYSTIC DEGENERATION AND LOW LEVEL ECHOES.	NIL	3	2	COLLOID GOITER WITH CYSTIC CHANGE.
21	SEETHE ANATHARAM	O15013544	42	F	HOARSENESS OF VOICE	RIGHT	HYPERECHOIC NODULE	INTERNAL	4	4	FOLLICULAR NEOPLASM.
22	LAKSHMI	O14020093	45	F	SWELLING IN THE NECK	RIGHT	WELL DEFINED ISO TO HYPOECHOIC NODULE WITH PERIPHERAL RIM OF HALO.	NIL	2	2	COLLOID GOITRE
23	VILASINI	O14088674	44	F	SWELLING IN THE NECK	RIGHT	ISOECHOIC NODULE WITH FEW CYSTIC CHANGES	NIL	2	2	COLLOID GOITRE

24	PALANIAMMAL	O13033414	83	F	DWEIGHT LOSS	LEFT	HETEROGENOUS NODULE	INTERNAL	5	4	PAPILLARY NEOPLASM
25	CHANDRASEKAR	O15000863	65	F	SWELLING IN THE NECK	LEFT	ISOECHOIC NODULE WITH CYSTIC CHANGES,	NIL	2	2	NODULAR GOITRE.
26	RAMATHAL	O14042921	62	F	WEIGHT LOSS	LEFT	HETEROGENOUS NODULE WITH CYSTIC AREA	INTERNAL	5	4	PAPILLARY CA
27	GOVINDAMMAL	I15007951	70	F	SWELLING IN THE NECK	LEFT	HETEROECHOIC NODULE .	PERIPHERAL	2	2	COLLOID GOITRE
28	MAHESH	H14001917	31	F	PAIN	RIGHT	HETEROGENOUS NODULE WITH FEW CYSTIC CHANGES.	PERIPHERAL	3	23	ADENOMATOUS NODULE OF COLLOID GOITRE.
29	KALAIARASI	O14014202	51	F	DYSPHAGIA	LEFT	HETEROGENOUS NODULE WITH FEW CYSTIC CHANGES.	NIL	2	3	ADENOMATOUS NODULE OF COLLOID GOITRE.
30	SHANTHI	O120191328	37	M	SWELLING IN THE NECK	RIGHT	HETEROGENOUS NODULE WITH FEW ANECHOIC AREAS IN THE RIGHT LOBE OF THYROID.	NIL	2	2	COLLIOD GOITRE